DIVISION OF ENVIRONMENT
QUALITY MANAGEMENT PLAN

PART III:

LAKE AND WETLAND WATER QUALITY MONITORING PROGRAM
QUALITY ASSURANCE MANAGEMENT PLAN

Kansas Department of Health and Environment
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Section 1

INTRODUCTION

1.1 Purpose of Document

This document presents the quality assurance (QA) management plan for the Kansas lake and wetland water quality monitoring program. Quality assurance goals, expectations, responsibilities, evaluation and reporting requirements are specifically addressed. Standard operating procedures (SOPs) used in this program are appended to the report or, in some cases, adopted by reference within the text of the report.

1.2 Historical Overview of Program

In 1975, the Kansas Department of Health and Environment (KDHE) initiated the forerunner of today's lake and wetland water quality monitoring program. The original program focused on nine large lakes (reservoirs) located at widely scattered locations within the state. Water samples were gathered from each lake at 3-10 offshore locations; additional samples were obtained from major tributaries entering the lakes and from outlet streams below the dams. Some lakes were sampled more than once in any given year. Often, three or more employees would camp at a given lake for as many as three or four days at a time. Most analytical measurements were performed onsite in a mobile laboratory facility.

The program continued in the above manner until 1983, when KDHE suspended routine lake monitoring while participating with the United States Geological Survey (USGS) in a two-year survey of public water supply lakes in Kansas. During this hiatus, an evaluation of the water quality monitoring program was conducted by KDHE to determine if any changes in monitoring protocols were needed. Statistical analysis of the accumulated database revealed that, within most lakes, year-to-year variation in water quality greatly exceeded variation between sampling points. A decision was made to maximize the number of lakes surveyed each year and to gather samples from a single location in each lake unless special circumstances dictated otherwise. Also, some chemical analyses were discontinued owing to their historical lack of application in regulatory management decisions. Another major program change in 1983 was the shifting of the analytical effort from the mobile laboratory facility to the central KDHE laboratory in Topeka. Collectively, these actions enhanced the QA and quality control (QC) aspects of the program, reduced the amount of time spent by staff at each lake, and facilitated the expansion of the sampling network without the need for additional staff or other resources.

By 1985, the above changes were fully implemented and a total of 22 lakes were surveyed by program staff. Also, for the first time, pesticide samples were collected from tributaries entering the larger federal lakes. These samples complemented data on pesticide concentrations in larger streams then being gathered by other departmental staff.

Over the next few years, the number of waterbodies included in the monitoring network increased to approximately 130 lakes, representative of all the major river basins and physiographic regions of Kansas. This expansion focused on lakes serving as public water supplies, but also included many other waterbodies of significant size or recreational import. In addition, a number of lakes in relatively undisturbed watersheds were added to the network as ecoregional reference sites. To accommodate this expansion in the face of limited resources, lakes were monitored on a rotational schedule involving visitations to 30-35 waterbodies per year. Large federal lakes were sampled on a three-year rotational schedule, whereas smaller lakes were sampled on a three- to six-year rotational schedule. This arrangement proved to be more efficient and flexible and provided a much broader geographic perspective on water quality conditions within the state.

The monitoring program continued to evolve after 1985. In 1988, seven publicly owned wetlands were included in the monitoring network and designated for sampling on a three-year rotational schedule. In 1989, the department began to assist communities and rural water districts with the identification and resolution of factors contributing to algal blooms and taste and odor problems in water supply lakes. Program staff also began to investigate the role of toxic algal blooms in fishkills, livestock deaths, and other reported phenomena.

In 1990, the KDHE stream chemistry monitoring network underwent several changes, some of which had a direct bearing on the lake and wetland monitoring program. For example, the stream network began to place increased emphasis on nonpoint source pollution control, watershed management, and the sampling of streams entering the major federal reservoirs. To avoid duplication of effort, lake monitoring staff discontinued the sampling of such streams and focused instead on obtaining water samples immediately below the outlets of the federal reservoirs. As of 1999, sampling of outlet streams has again been shifted to the stream chemistry monitoring network.

In 1991 and 1992, macrophyte community surveys were initiated for selected network lakes under 300 acres in size. Also, watersheds associated with selected network lakes and wetlands were subjected to land use analysis to better document the sources of contaminants contributing to observed water use impairments.

As of December 2000, a total of 119 waterbodies were included in the lake and wetland water quality monitoring network (Figure 1.2-1). This number will likely change over time as new lakes are constructed and older lakes are dewatered or replaced by more accessible and/or suitable candidate sites.

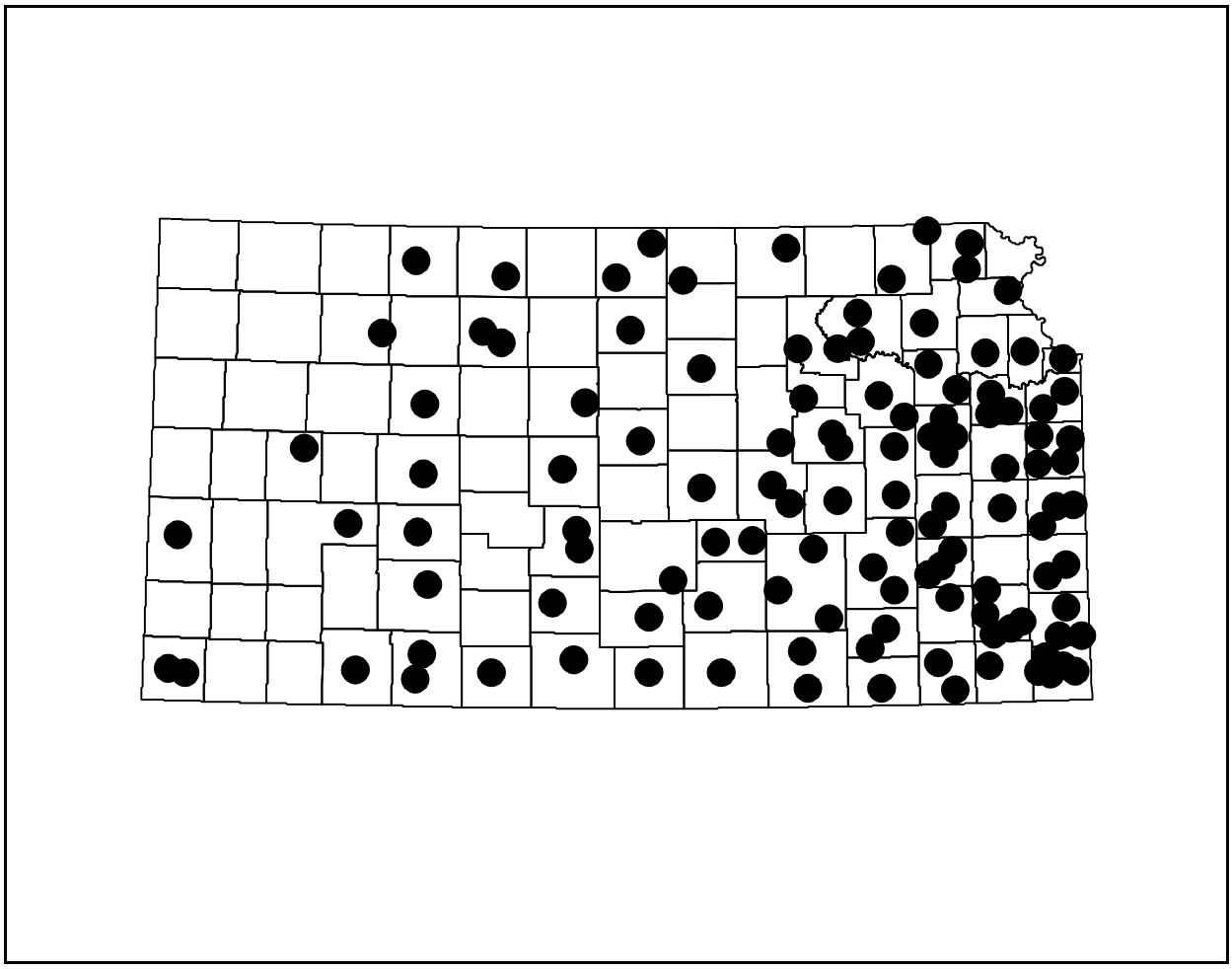


Figure 1.2-1. Current distribution of monitored waterbodies in lake and wetland water quality monitoring network.

1.3 Contemporary Program Objectives

The Kansas lake and wetland water quality monitoring program endeavors to provide reliable information on the physicochemical and biological characteristics of publicly owned waterbodies. This information is used in:

(1) complying with the water quality monitoring and reporting requirements of 40 CFR 130.4 and sections 106(e)(1), 303(d) and 305(b) of the federal Clean Water Act;

(2) evaluating waterbody compliance with the Kansas surface water quality standards (K.A.R. 28-16-28b *et seq*.);

(3) identifying point and nonpoint sources of pollution contributing most significantly to water use impairments in publicly owned lakes and wetlands;

(4) documenting spatial and temporal trends in surface water quality resulting from changes in land use patterns, resource management practices, and climatological conditions;

(5) developing scientifically defensible environmental standards, wastewater treatment plant permits, and waterbody/watershed pollution control plans; and

(6) evaluating the efficacy of pollution control efforts and waterbody remediation/restoration initiatives implemented by the department and other agencies and organizations.

Section 2

QUALITY ASSURANCE GOALS AND EXPECTATIONS

The foremost goal of this QA management plan is to ensure that the Kansas lake and wetland water quality monitoring program produces data of known and acceptable quality. "Known quality" means that the precision, accuracy, completeness, comparability and overall representativeness of the data are documented to the fullest practicable extent. "Acceptable" means that the data support, in a scientifically defensible manner, the informational needs and regulatory functions of the Bureau of Environmental Field Services (BEFS), the division, and the agency. The success of the program in meeting this general goal is judged on the basis of the following QA/QC performance criteria and requirements:

(1) Where practicable, the reliability of program data shall be documented in a quantitative fashion. For routine water chemistry parameters, the precision of the data shall be evaluated through the use of replicate samples and the accuracy of the data shall be evaluated through the use of sample blanks and spiked samples. The average coefficient of variation among duplicate and replicate samples shall, for all parameters, be less than twenty percent; field spike recoveries shall average between 80 and 120 percent of the actual spike concentrations; background contaminant levels (determined primarily through the analysis of field blanks) shall constitute, on average, less than ten percent of the reported sample concentrations.

(2) Loss of physicochemical and biological data due to sample collection, transport or analytical problems, or to the subsequent mishandling of data, shall be limited to less than five percent of the data originally scheduled for generation. Where problems occur and data is lost, an effort shall be made to resample (within the same rotational cycle) the effected lake or wetland to maximize data completeness.

The previous statement does not include circumstances where lakes and wetlands, that have been scheduled for sampling, are found to be in a de-watered state due to climate or maintenance activity. This is not considered to be a “lost data” condition. In such cases, re-sampling is postponed until the waterbody becomes replenished and equilibrium water quality is reestablished.

In the case of wetlands, sampling will be postponed until the following year, or such time as replenishment is believed probable. Wetlands are assumed to reestablish a water quality equilibrium more rapidly than lakes, based on the fact that most undergo wet-dry cycles every few years.

(3) Changes in the methods used to obtain and analyze water samples shall be carefully documented through formal revisions to the SOPs appended to this QA management plan. This requirement is intended to help maintain a reasonably consistent database over time, enhance knowledge of the effects of any procedural changes on reported contaminant concentrations, and facilitate the identification and evaluation of long-term trends in surface water quality.

(4) Data generated through this program shall be compared and contrasted with other available monitoring data to examine the representativeness of program findings relative to other reported results. Staff shall attempt to ascertain the probable causes of any discrepancies observed between the various existing databases and describe, in end-of-year program reports, the magnitude and practical significance of such discrepancies in reported water quality and ecology.

Section 3

QUALITY ASSURANCE ORGANIZATION

3.1 Administrative Organization

The lake and wetland water quality monitoring program is one of several statewide environmental monitoring programs administered by the Technical Services Section, Bureau of Environmental Field Services (see BEFS QA Management Plan, QMP, Part II). Program offices are located at Forbes Field in Topeka, Kansas.

3.2 Staff Responsibilities

Program staff include one environmental scientist and one environmental technician. The environmental scientist serves as the program manager and is accountable for most planning, scheduling, site selection, field sampling, BEFS laboratory analysis, data analysis, and report writing activities. The environmental technician is responsible for day-to-day maintenance of field equipment and assists in planning, scheduling, sampling, sample analysis, and data validation.

Personnel from other programs within BEFS occasionally assist with lake and wetland sampling activities, especially in the event of staff absences or when additional people are needed to conduct work in a timely, safe, and efficient fashion. Staff of the lake and wetland water quality monitoring program provide reciprocal assistance to other BEFS programs.

3.3 Staff Qualifications and Training

Minimum technical qualifications for program staff vary by position. The program manager must hold at least a four-year college degree in limnology, aquatic biology, environmental microbiology or a related scientific field and have substantial experience in the performance of water quality studies and associated data analysis and statistical procedures. The program manager must also understand the basic principles of supervision, program administration and quality control and possess advanced computer skills and written and oral communication skills. Also, pursuant to Part I of the divisional quality management plan (QMP), the program manager must complete formal supervisory training offered by the Kansas Department of Administration and quality assurance training offered by EPA. The program's environmental technician II (and all other employees routinely assisting with this program) must command a thorough understanding of the procedures used in the collection, handling and preliminary analysis of surface water samples and in the processing of associated paperwork and other documentation.

All individuals routinely participating in this program must possess a valid Kansas driver's license and current certifications in first aid and cardiopulmonary resuscitation (CPR). They must review the program’s QA management plan and SOPs prior to assuming field/laboratory duties and repeat

this review at least annually (QMP, Part I). All program staff receive in-house training in applicable work procedures and related safety requirements. As funding and other agency resources allow, the program manager and the environmental technician II are encouraged to participate in technical workshops and seminars dealing with environmental monitoring operations and related field, analytical, data management and statistical procedures.

Section 4

QUALITY ASSURANCE PROCEDURES

4.1 Monitoring Site Selection

Lakes and wetlands are selected for inclusion in the monitoring network based on several considerations. Large, multipurpose federal reservoirs represent a major fraction of the total lake acreage in Kansas, constitute premier recreational resources, provide important fish and wildlife habitat and, in several instances, serve as drinking water supply reservoirs; hence, they are given a high priority in the monitoring program. Other large water supply lakes and public recreational impoundments are likewise considered excellent candidates for inclusion in the monitoring network. Wetlands are incorporated into the network based on their size, importance to migratory waterfowl and threatened/endangered species, and accessibility to the public for hunting, bird watching, and other recreational activities.

Another factor influencing recent selections has been the desire to maintain a reasonable apportionment of sites among the major river basins and physiographic regions of Kansas. An effort has been made to select lakes from the various size (acreage) categories present within each of these geographic areas. Where a major basin or physiographic region lacks larger multipurpose reservoirs or water supply lakes, smaller recreational waterbodies generally are chosen. Boating access is an important consideration in the selection of these smaller lakes. Lakes and wetlands may be eliminated from the network if more accessible or representative waterbodies are located. Resources currently allotted to the monitoring program permit the inclusion of approximately 130 lakes and wetlands in the sampling network.

4.2 Field Protocols

4.2.1 Water Sampling Activities

Water samples are collected from each lake and wetland with the aid of a 14-foot Jon boat or, in larger lakes, an 18-foot pontoon boat. The boat is anchored over the deepest point in the waterbody during sampling activities. In wetlands, this point typically coincides with the center of the largest pool although, due to a lack of boat access, some wetlands are sampled at the main outflow structure. In lakes, the deepest water generally overlies the inundated stream channel within 30-60 meters of the face of the dam. The exact distance from the dam varies from lake to lake depending upon the design and slope of the dam, the size and depth of the lake, and other factors.

Although a single sampling station per lake is the network norm, special studies or unusual conditions may necessitate additional sampling points within a given waterbody. The rationale for inclusion and placement of additional monitoring stations varies with each circumstance and, therefore, is not readily amenable to a priori description. Sampling protocols presented below are

generally applicable to any added sampling station. The location of each sampling point is permanently documented as header information in the EPA STORET database and in hardcopy file documentation maintained by the program manager.

Several types of samples are gathered by program staff, and each is transported and stored in its own specific kind of container (Appendix B). A complete array of inorganic samples requires the use of one-quart plastic cubitainers ("mineral" parameters and chlorophyll-a), 175-ml Nalgene bottles ("nutrient" parameters), and acid-washed 250-ml Nalgene bottles ("heavy metal" parameters). One-gallon dark glass bottles with Teflon-lined plastic caps are used for the collection of pesticide samples. Samples for the analysis of volatile organic compounds (VOCs) are contained in 40-ml glass vials with Teflon-lined plastic caps, although these samples are rarely collected for Kansas lakes and wetlands. Phytoplankton samples are contained in 125-ml brown polyethylene bottles. Bacteriological samples require the use of sterilized (autoclaved) 250-ml polyethylene bottles.

In lakes, samples for the measurement of inorganic constituents (minerals, nutrients, heavy metals) are collected 0.5 meter below the surface of the water and 0.5-1.0 meter above the lake sediments using a Kemmerer sampling apparatus. To minimize the risk of sample contamination, the Kemmerer apparatus is rinsed repeatedly with lake water prior to use. One "pull" from a depth of 0.5 meter fills one set of surface sample containers; a second pull from the same depth is taken to fill the duplicate sample containers. This procedure is repeated for the bottom sample and duplicate bottom sample. (Prior to filling bottom sample containers, the Kemmerer apparatus is "bled" to ensure that no sediment has been collected in the release valve.) In general, bottom samples are not collected from unstratified lakes less than 2.0 meters in maximum depth. If a shallow lake exhibits thermal stratification, field staff collect bottom samples only if it is believed that the activity can be performed without disturbing the sediments and jeopardizing the representativeness of the sample. Bottom samples are not routinely collected from wetlands owing to their extremely shallow nature.

Pesticide samples are collected from lakes and wetlands by manually submerging a one-gallon dark glass bottle and allowing the bottle to fill at a depth of 0.5 meter. Phytoplankton samples are also gathered, in duplicate, by manually submerging 125 ml brown plastic bottles to a depth of 0.5 meter. Sediment and depth-integrated zooplankton samples are reserved for special investigations and, therefore, are not described in detail in this QA management plan (see Appendix B).

Bacteriological samples are routinely obtained from open water stations at a depth of 0.5 meter using the Kemmerer apparatus. Where boat access is limited or during complaint investigations, samples may be taken from swimming beaches, boat docks, or fish cleaning stations using an extendable pole with a small, polyvinyl chloride sampling "bucket" at one end. Samples are collected 3-4 meters from the shore or end of the dock, and from a few centimeters beneath the water surface to avoid materials floating at the air/water interface. On occasion, a fish cleaning station may be equipped with a small hand pump that draws water from just beneath the surface of the water. Bacterial samples may be collected directly from such pumps, provided pumps and associated pipes are first flushed with at least five volumes of lake water. Streams entering or exiting lakes/wetlands usually are sampled from bridges. A specially fabricated, stainless steel sampling bucket is manually lowered into the water on a rope. The sample is collected from the deepest appearing portion of the

stream channel in order to minimize resuspension of sediments. Samples are normally collected on the upstream side of bridges, unless safety concerns or obstructions dictate otherwise.

4.2.2 Macrophyte Sampling Activities

Macrophyte sampling techniques are derived from the point-quadrat method used for terrestrial vegetation analyses. At each lake, sampling activities are conducted at 10-20 locations depending on the surface area of the waterbody. Sampling points are arranged in a regular grid pattern and are first identified on a map of the lake copied from one or more USGS 1:24,000 scale topographic maps. The boat is maneuvered to each site indicated on the map, and the approximate position of the site is confirmed by visual cross reference to several topographic features along the shoreline.

Staff inspect each site for any evidence of a resident macrophyte community. A grapnel hook attached to a rope is thrown over the boat, drawn over the lake sediments for a distance of 5-6 meters, and manually retrieved. Macrophyte specimens snared on the hook are identified immediately, and the species names are recorded on a data sheet (APP.C-3). Specimens that cannot be identified in the field are brought back to the office in plastic bags and stored at 4^{o}C, in the dark, pending identification (Wood, 1967; Fassett, 1972; Winterringer & Lopinot, 1977; and Brooks & Hauser, 1981). Macrophyte abundance is reported as "percent of stations with macrophytes" and is used as a surrogate of areal cover. The same metric is applied to each species as a measure of relative species abundance. The number of species documented gives an estimate of species richness.

4.2.3 Field Measurements

Temperature and dissolved oxygen (DO) concentrations are measured at 0.5- or one-meter depth intervals with a Yellow Springs Instrument (YSI) model 51B portable meter, coupled to a YSI combination thermistor/DO membrane probe (APHA, 1992; see also section 4.4.2). A standard 20-cm black and white Secchi disc is used to measure water column transparency. All Secchi depth measurements are made on the shaded side of the boat, and the mean of the disappearance and reappearance depths is recorded. Using aliquots from the two "surface" and two "bottom" sample cubitainers, pH is measured immediately upon return to shore after standardizing the meter as per manufacturers guidelines (Appendix B; section 4.4.3). Using a Li-Cor model LI-192SA underwater quantum sensor, light profiles are obtained by measuring illumination at the surface and at 0.5- or one-meter depth intervals to a depth receiving approximately 1% of the light recorded at the surface (Appendix B; section 4.4.5).

4.2.4 Sample Preservation

Mineral, nutrient, heavy metal, pesticide, chlorophyll-a and bacteriological samples collected during lake/wetland monitoring efforts require storage in the dark, at approximately 4^{o}C, pending transfer to the Kansas Health and Environmental Laboratory (KHEL) in Topeka. Appendix B describes appropriate sample containers, preservation techniques, and storage and holding-time requirements for individual parameters.

Heavy metal sample bottles supplied by KHEL are pre-acidified with nitric acid. Nutrient sample bottles are either pre-acidified with sulfuric acid or, alternatively, require the addition of 1 ml of 1:30 (v/v) sulfuric acid solution following sample collection. In the latter case, the acid is added to nutrient sample bottles immediately upon return to shore.

Winkler dissolved oxygen samples, which provide an independent check on the performance of the YSI DO probe/meter, are preserved upon return to shore with appropriate additions of $MnSO_4$, alkaline potassium iodide azide, and (after the appropriate settling time) concentrated sulfuric acid (APHA, 1992). Once the sulfuric acid is added, the sample bottles are stored in the dark pending transfer to Topeka for titration (APHA, 1992). Ideally, the Winkler sample is the last sample collected before concluding a lake survey.

Chlorophyll-a samples must be filtered within 72 hours of collection. Filters are stored in a freezer pending extraction and analysis, and a maximum holding time of 15 weeks is applied to all frozen filters. This activity is conducted at the BEFS office in Topeka (section 4.41, below).

Algae and zooplankton samples may be kept indefinitely, provided the preservative is periodically renewed; however, such samples generally are analyzed within six months of the end of the sampling season (ends about mid-September). Samples collected for algal taxonomy are preserved with 1.0-1.5 ml of Lugol's solution for each 100 ml of sample (APHA, 1992). Zooplankton samples, when collected, are washed into collection jars using 70 percent ethanol and stored in the dark at room temperature (APHA, 1992). Macrophyte specimens that cannot be identified in the field are transported to the Topeka office in sealed plastic bags, maintained on ice and in the dark to minimize decomposition.

4.3 Sample Transport, Chain-of-Custody and Holding Times

All samples must be handled and stored in a fashion which minimizes contamination, leakage and damage during transport. Most samples are transferred to KHEL, where a variety of physical, chemical and microbiological measurements are performed. However, several measurements are performed in the field or at the BEFS shop facility at Forbes Field. As a rule, no sample arrives at KHEL or the BEFS facility later than 72 hours after collection. Under normal sampling conditions, samples are delivered within 48 hours. This still exceeds the standard holding time for dissolved oxygen samples (immediate) and may exceed the standard holding time for fecal coliform bacteria samples (24 hours). Quality control studies conducted by BEFS have shown no holding time effect for dissolved oxygen once samples are acidified; however, reported bacterial concentrations may be slightly less than actual ambient levels owing to die-off within the sample. These changes have been accepted within the program owing to logistical constraints. A standardized sample submission (chain-of-custody) form is completed for each sample submitted to KHEL (Appendix C, Form 2). The form identifies the sampling location, date and time, the personnel involved in the collection of the sample, and the analytical parameters of interest; it also assigns to the sample a unique identification number for future reference. Staff involved with the collection of the sample sign the form, date it, and deliver it (with the sample) to KHEL. Staff of KHEL sign the form and record the date and time of sample submission on the form to acknowledge receipt of the sample. This basic sign-off procedure also is repeated in the event the sample changes hands prior to arrival at KHEL.

Winkler dissolved oxygen analyses, chlorophyll-a analyses, and plankton/macrophyte identification and enumeration are conducted in the BEFS shop/laboratory facility. Program field staff are ultimately responsible for implementing proper handling, transport, chain-of-custody, and analytical procedures for these samples.

4.4 Analytical Procedures Performed by Program Staff

Most chemical and all bacteriological analyses are performed by KHEL staff (tables 4.4-1, 4.4-2, 4.4-3). However, staff of the lake and wetland water quality monitoring program perform several analytical measurements, as described in the following subsections.

4.4.1 Chlorophyll-a Analyses

These analyses are among the most time consuming procedures performed by program staff. Water samples collected for chlorophyll-a determination must be filtered within 72 hours of collection through a Gelman (Type A/E) glass-fiber filter. Filters are then folded (using forceps only), wrapped in a paper blotter, labeled, packed in plastic bags with dessicated dry-rite compound, and placed in a freezer. After 12 to 15 weeks of freeze-drying, the filters are ground with 90 percent acetone in a tissue grinder, spun down in a centrifuge, and readings are taken at several wavelengths using a UV/visible spectrophotometer. Chlorophyll-a concentrations are calculated pursuant to Standard Methods (APHA, 1992).

4.4.2 Temperature and Dissolved Oxygen Analyses

Temperature and dissolved oxygen (DO) are measured using an air-calibrated YSI model 51b DO meter. The air-calibration is conducted according to manufacturer guidelines. However, a water sample is always collected to check the DO meter performance against the results of a Winkler titration, as outlined in the latest Standard Methods (see also Appendix B).

4.4.3 pH Analyses

pH measurements are performed with a Cole-Parmer model 5996-80 portable pH meter. The meter is standardized using pH 4.0, 7.0 and 10.0 buffer solutions traceable to the National Bureau of Standards. Once standardized, the combination sample/reference pH probe is stored in a receptacle of deionized water. After use, the probe is rinsed with deionized water, dipped in pH 4.0 buffer, and replaced in its protective cover (Appendix B).

4.4.4 Phytoplankton Identification and Enumeration

Preserved phytoplankton samples are transported to Topeka in a cool (air conditioned), dark location within the sampling van. Within 72 hours of collection, these samples are poured into 100 ml settling tubes and left undisturbed for one to two weeks. At the end of this period, 80 percent of the water is siphoned off using a vacuum pump that pulls the water off the surface of the settling tubes, leaving the settled material undisturbed. After the sample is thus concentrated, the remaining 20 percent of the sample is agitated to resuspend the algae and poured into a 25-ml glass vial for storage until taxonomic work can commence.

The principal devices for algal taxonomy are a Wilde inverted microscope and a modified Sedgwick-Rafter counting cell. An aliquot from a particular glass storage vial is placed in a counting cell of known dimensions for each magnification on the microscope. Cell counts are almost exclusively conducted using the 400X setting; counts are performed on 50 microscope fields selected at random. Results are recorded as total cells, or cells of a particular taxonomic group, in units of cells/ml. Biovolume is calculated for each taxon by multiplying the average estimated cell volume by the estimated number of cells.

4.4.5 Light Profile Analysis

Data concerning the level of remaining surface light at various depths in the water column are collected using a Li-Cor model LI-192SA underwater quantum meter. The meter is calibrated automatically, and the coefficients applied in this process are recalculated every two years by the manufacturer.

4.5 Internal Procedures for Assessing Data Precision, Accuracy, Representativeness and Comparability

4.5.1 Inhouse Audits

The section chief conducts annual audits of field and laboratory equipment and procedures. Each audit is comprised of a system audit, consisting of a qualitative, onsite review of QA systems and physical facilities for monitoring, measurement and calibration, and a performance audit, in which a quantitative assessment is made of the bias (accuracy) and variability (precision) of analytical measurements. During system audits, staff responsible for sample collection and field operations are required to demonstrate a proper understanding of the requirements imposed by the program QA management plan and accompanying SOPs. During performance audits, staff are required to conduct field measurements in the presence of the section chief and to report measured values for pH, DO, temperature, and other parameters that fall within five percent of the values established by the section chief. Should these values fall outside the control limits, the section chief and program staff initiate corrective actions as described in section 4.7.

TABLE 4.4-1

ROUTINE INORGANIC ANALYSES PERFORMED BY KHEL

Parameter	Reporting Limit	Reporting Unit	Analytical Method
Alkalinity	1	mg/L	EPA 310.2
Aluminum	50	ug/L	EPA 200.7
Ammonia	0.01	mg/L	EPA 350.1
Antimony	50	ug/L	EPA 200.7
Arsenic	1	ug/L	EPA 200.9
Barium	5	ug/L	EPA 200.7
Beryllium	1	ug/L	EPA 200.7
Boron	0.01	mg/L	EPA 200.7
Bromide	0.01	mg/L	EPA 300.0
Cadmium	1	ug/L	EPA 200.9
Calcium	0.05	mg/L	EPA 200.7
Chloride	0.01	mg/L	EPA 300.0
Chromium	1	ug/L	EPA 200.9
Cobalt	10	ug/L	EPA 200.7
Copper	10	ug/L	EPA 200.9
Fluoride	0.05	mg/L	EPA 300.0
Iron	10	ug/L	EPA 200.7
Kjeldahl Nitrogen	0.1	mg/L	EPA 351.1
Lead	1	ug/L	EPA 200.9
Magnesium	0.05	mg/L	EPA 200.7
Manganese	5	ug/L	EPA 200.7
Mercury	0.5	ug/L	EPA 245.2
Molybdenum	10	ug/L	EPA 200.7
Nitrate (N)	0.01	mg/L	EPA 300.0
Nitrite (N)	0.05	mg/L	EPA 300.0
Ortho-Phosphate (P)	0.01	mg/L	EPA 300.0

TABLE 4.4-1 (Continued)

ROUTINE INORGANIC ANALYSES PERFORMED BY KHEL

Parameter	Reporting Limit	Reporting Unit	Analytical Method
Potassium	0.3	mg/L	EPA 200.7
Selenium	2	ug/L	EPA 200.9
Silica	0.1	ug/L	EPA 200.7
Silver	1	ug/L	EPA 200.9
Sodium	0.05	mg/L	EPA 200.7
Specific Conductance	variable	umho/cm	EPA 120.1
Sulphate	0.01	mg/L	EPA 300.0
Thallium	50	ug/L	EPA 200.7
Total Dissolved Solids	calculated	mg/L	USGS I751-8
Total Hardness	calculated	mg/L	SM 2340B
Total Organic Carbon	0.5	mg/L	SM 310B
Total Phosphorus (P)	0.01	mg/L	EPA 365.1
Total Suspended Solids	1	mg/L	EPA 160.2
Turbidity	0.5	NTU	EPA 180.1
Vanadium	5	ug/L	EPA 200.7
Zinc	5	ug/L	EPA 200.7

TABLE 4.4-2

ROUTINE ORGANIC ANALYSES PERFORMED BY KHEL

Parameter	Reporting Limit	Reporting Unit	Analytical Method
Alachlor	0.100	ug/L	EPA 608
Aldrin	0.025	ug/L	EPA 608
Atrazine	0.300	ug/L	EPA 608
Butachlor	0.500	ug/L	EPA 608
Chlordane	0.200	ug/L	EPA 608
Cyanazine (Bladex)	0.500	ug/L	EPA 608
DCPA (Dacthal)	0.050	ug/L	EPA 608
Dieldrin	0.050	ug/L	EPA 608
Endrin	0.100	ug/L	EPA 608
Gamma BHC (Lindane)	0.025	ug/L	EPA 608
Heptachlor	0.020	ug/L	EPA 608
Heptachlor Epoxide	0.020	ug/L	EPA 608
Hexachlorobenzene	0.100	ug/L	EPA 608
Methoxychlor	0.200	ug/L	EPA 608
Metolachlor (Dual)	0.250	ug/L	EPA 608
Metribuzen (Sencor)	0.100	ug/L	EPA 608
PCB-1016	0.500	ug/L	EPA 608
PCB-1221	2.500	ug/L	EPA 608
PCB-1232	0.500	ug/L	EPA 608
PCB-1242	0.500	ug/L	EPA 608
PCB-1248	0.500	ug/L	EPA 608
PCB-1254	0.500	ug/L	EPA 608
PCB-1260	0.500	ug/L	EPA 608
Picloram (Tordon)	0.800	ug/L	EPA 615
Propachlor (Ramrod)	0.250	ug/L	EPA 608

TABLE 4.4-2 (Continued)

ROUTINE ORGANIC ANALYSES PERFORMED BY KHEL

Parameter	Reporting Limit	Reporting Unit	Analytical Method
Propazine (Milogard)	0.300	ug/L	EPA 608
Simazine	0.300	ug/L	EPA 608
Toxaphene	2.000	ug/L	EPA 608
2,4-D as Acid	0.800	ug/L	EPA 615
2,4,5-T as Acid	0.400	ug/L	EPA 615
2,4,5-TP as Acid (Silvex)	0.400	ug/L	EPA 615

TABLE 4.4-3

ROUTINE BACTERIOLOGICAL ANALYSES PERFORMED BY KHEL

Parameter	Reporting Limit	Reporting Unit	Analytical Method
Fecal Coliform Bacteria	variable	cfu/100 ml	SM 9222D

4.5.2 Instrument Calibration and Standardization

Before leaving for the field, monitoring staff are expected to calibrate the pH and DO meters and test these instruments for normal operation. Similarly, the performance of all thermometers used in the field must be checked against an NBS-traceable reference thermometer. The pH meter is standardized immediately prior to use in the field using NBS-traceable pH buffer solutions (Appendix B). All instruments must meet manufacturer performance specifications. If meters are found to drift significantly, more frequent calibrations are performed or corrective action procedures are invoked (section 4.7).

4.5.3 Procedural Blanks

The possibility of sample contamination during sample preparation, storage and analysis is evaluated through the use of procedural blanks, prepared with demineralized water and subjected to the same treatment as lake/wetland samples. (Contamination is an especially important consideration when sampling for trace metals, as concentrations of these parameters in lakes and wetlands frequently are less than 1.0 ug/L, and sample concentrations may be greatly augmented through exposure to airborne particulate matter, etc.) For approximately every ten lakes visited by staff, a complete set of sample containers is selected at random, filled under field conditions with laboratory water initially meeting Type-I specifications, and sealed, transported, stored and analyzed along with the

other field samples. (The Kemmerer apparatus used to collect samples is rinsed several times with deionized water, then filled with deionized water and used to fill the blank sample containers.) If the QC limits of section 2, paragraph (1), are exceeded, corrective action procedures are implemented in accordance with section 4.7.

4.5.4 Duplicate Samples and Spiked Samples

Quality control measures in the lake and wetland water quality monitoring program also include the use of duplicate samples and spiked samples. Duplicate pesticide samples are collected from a minimum of one lake or wetland in every ten waterbodies visited by field staff; for all other chemistry parameters, duplicate samples are collected each time a lake or wetland is visited by program staff. At least twice each sampling season, duplicate water samples are spiked with known concentrations of selected parameters and submitted to KHEL in "blind" fashion. These samples are prepared under the supervision of the program manager in the relatively controlled environment of the BEFS basement shop using volumetric glassware and reference solutions provided by the United States Environmental Protection Agency, the United States Geological Survey, or appropriate commercial sources. The corrective action procedures of section 4.7 are invoked if the precision or accuracy of the data falls outside the control limits established in section 2.

4.5.5 Preventative Maintenance

Periodic inspection of sampling and analytical equipment and routine maintenance of such equipment is necessary to minimize malfunctions which could result in the loss of data or disruption of project activities. Field instrumentation is routinely inspected prior to use and calibrated at intervals recommended by the manufacturer, and equipment maintenance logs are maintained for all pH meters, DO meters, light meters, and spectrophotometers. Vehicles used for field activities must be maintained in a reliable condition and kept free of trash, debris or other materials that could significantly increase the risk of sample contamination. Entries are made in the vehicle log upon the completion of each field trip. Instrument and vehicle malfunctions are reported to the program manager as soon as possible to expedite necessary repairs or the acquisition of new equipment (section 4.7).

4.5.6 Safety Considerations

Safety should be a constant concern of all staff involved in field work. Safety protocols may be lumped into two basic categories: those related to natural phenomena and those related to staff actions and equipment.

Natural safety hazards include weather conditions, problems related to local terrain, and biological hazards. Weather is an important safety consideration in all outdoor environmental monitoring activities, but especially on the open waters of lakes and wetlands. Sampling activities should be postponed if weather conditions impose an immediate threat, whether related to wind, lightning, hail, flood waters, or extreme temperature or heat index. Field staff must exercise their best judgement when adverse weather conditions are encountered. If weather conditions are not threatening, but may impair the representativeness of the samples being collected, field staff should reschedule field activities.

Many forms of terrain may present serious safety concerns. In some areas of the state, sink holes and subsidence features may pose a safety hazard. Likewise, loose gravel, steep embankments, and algal-coated rocks may create poor footing. Field staff must exercise sound judgement when encountering situations that pose a potential for falling and injury.

Field staff also may encounter plants and animals that produce irritating, or harmful, biochemical compounds. These may include plants (poison ivy, nettles, blue-green algae), animals (skunks, snakes), or insects and other invertebrates (wasps, ticks, etc.). While most encounters may be avoided by careful observation or precautions, some encounters may be sudden and unanticipated. Once again, cultivating good judgement is the primary defense for field staff. In addition to honing one's level of awareness and judgement in the field, training in basic first aid and cardiopulmonary resuscitation techniques is expected of all field staff routinely involved in the monitoring program.

Safety concerns related to staff activity and the use of equipment include operation of state vehicles and boats, sampling devices (such as Ponar dredges) that pose a potential danger to fingers and hands, and the handling of glassware and chemicals. Proficiency in driving and attentiveness to the rules of the road are also a must for field staff. The same applies to the operation of boats. Staff routinely involved in the use of boats are encouraged to participate in boating safety courses offered by the Kansas Department of Wildlife and Parks, the Coast Guard, and other qualified agencies and organizations.

Sampling devices that could injure fingers and hands should not be used unless field staff have been trained in the activity by personnel proficient in the utilization of such equipment. Even after such training, accidents are possible if the user does not exercise good judgement. The same applies to the handling of glassware and chemicals used in the field. Chemicals used by staff in the field include manganous sulphate (eye and mucous membrane irritant), alkaline potassium azide-iodide (toxic if ingested), concentrated sulfuric acid (strong acid and oxidizer), dilute sulfuric acid (irritant to skin, eyes, etc.), nitric acid (strong acid and oxidizer used as preservative in heavy metal sample bottles), pH buffer solutions (eye and mucous membrane irritants), and Lugol's iodine (toxic if ingested and readily stains skin and clothing). When zooplankton samples are collected, ethanol, which is highly flammable, is also used in the field. Field staff must exercise sound judgement in handling and applying these chemicals. Staff should not engage in the use of such materials when the weather or terrain makes firm footing a problem. Rather, staff should move to a level, dry, protected area before preserving or analyzing samples. If the wind is blowing, staff should not apply chemicals to samples while holding the bottle upwind of their face and eyes.

Field equipment, including boats and sampling vehicles, must periodically be inspected for mechanical, electrical or structural defects or other problems that could jeopardize the safety of staff. Likewise, fire extinguishers and first aid kits should be inspected annually, or more frequently if used in the field. If problems are noted, they must be brought to the attention of the program manager and repaired or corrected in a timely fashion. Safety equipment carried in the program van and boats includes first aid kits, fire extinguishers, life vests, and signal horn. In summary, forethought, preparation and common sense are the primary safeguards against accidents on the road and in the field (LWMP-006).

A number of potentially hazardous chemicals are also used by laboratory personnel. These include acetone (flammable, potentially toxic, and an eye and mucous membrane irritant), dilute hydrochloric acid (eye and mucous membrane irritant), Lugol's iodine (an irritant and staining agent), pH buffer solutions (eye and mucous membrane irritants), and the titrant used in Winkler dissolved oxygen determination (eye and mucous membrane irritant). Of these, acetone represents the primary health threat. Chlorophyll-a sample preparation and analysis should be conducted only under well ventilated conditions owing to the use of acetone.

Other hazards in the laboratory include broken glassware and the use of power equipment. Care should be taken to keep flammable chemicals or fumes from building up in areas where electrical equipment is used. The primary defense against laboratory accidents is for staff to become familiar with the properties of the materials they are handling, and behave in an alert and cautious manner in the presence of such materials. Staff should be aware of the location and operation of laboratory fire extinguishers, eye wash stations, fire exits, and spill kits.

4.6 External Procedures for Assessing Data Precision, Accuracy, Representativeness and Comparability

At the discretion of the section chief, bureau QA representative, bureau director, or divisional QA officer, the lake and wetland monitoring program may, from time to time, participate in independent performance/system audits or in cooperative, interlaboratory sample comparison programs or reference sample programs. Participation in such activities promotes scientific peer review and enhances the technical integrity and overall credibility of the program.

4.7 Corrective Action Procedures for Out-of-Control Situations

4.7.1 Equipment Malfunction

Any instrument malfunction discovered by staff during routine calibration activities or during an internal or external performance audit shall be recorded in the appropriate logbook and immediately reported to the program manager. The program manager is responsible for appraising the scope and seriousness of the problem and, if necessary, for determining whether the instrument should be repaired or replaced. The program manager also is responsible for locating backup instrumentation for critical field activities. Similarly, provisions for a backup sampling vehicle must be made in the event of any mechanical problems or mishaps that might render the primary sampling vehicle inoperable for an extended period.

4.7.2 Sample Contamination

Blank concentrations outside the control limits established in section 2, paragraph (1), detract from the quality and credibility of the lake and wetland water quality data and must be resolved in a timely manner. In instances where the source of contamination is unknown, the program manager shall initiate an investigation to determine whether the problem is of field or laboratory origin. Field contamination problems may result, for example, from improper sample collection techniques or exposure to contamination sources at the sampling site or within the vehicle used to transport the samples. Laboratory problems may include contaminated water supply or reagents, contaminated

glassware, or some less conspicuous problem. Staff and the program manager shall work closely with KHEL personnel to identify and eliminate the contamination sources. Persistent problems may trigger a program audit and result in the removal of questionable data from the lake/wetland water quality database.

4.7.3 Data Precision/Accuracy Problems

Should water quality data fail to meet the precision and accuracy requirements of section 2, paragraph (1), the program manager shall initiate an investigation to determine the cause of the problem and implement appropriate corrective measures. Persistent problems may trigger an internal or external program audit and result in the disqualification of a substantial amount of water quality data.

4.7.4 Staff Performance Problems

Should program staff have difficulty with a given work procedure (e.g., as determined by an internal performance audit), an effort shall be made by the program manager to identify the scope and seriousness of the problem, to identify any data effected by the problem, and to recommend to the section chief an appropriate course of corrective action. Questionable data are either flagged in the computer database or, at the section chief's discretion, deleted from the database. Corrective actions may include further inhouse or external training for the employee, a reassignment of work duties, or modification of the work procedure.

4.8 Data Management

4.8.1 General Data Management

All field- and laboratory-generated data on lake/wetland water quality are handled in an orderly and consistent manner. Time and date of sample collection, waterbody identification number, and other basic information are recorded on standardized sample submission forms (Appendix C). The original forms are retained by sampling staff and routed to the program manager for filing; copies of forms are submitted to KHEL, along with the samples. Upon completion of the laboratory analyses, the KHEL computer automatically downloads the data to the Kansas Water Database, which is accessed through the KDHE IBM AS-400 computer system. The database is supported and backed-up daily by the KDHE Office of Information Systems (OIS).

Hardcopies of all physicochemical and bacteriological data generated by KHEL are stored in the BEFS files. After error checking of the database at the end of each sampling season (see section 4.8.2, below), the laboratory data is electronically downloaded into the EPA STORET database. Field data for pH, temperature, and dissolved oxygen likewise are loaded onto electronic spreadsheets, checked for obvious errors or omissions, and downloaded onto STORET at the end of each sampling season.

The same applies to the chlorophyll-a and light profile data generated by BEFS staff. Taxonomic data for plankton and macrophytes remains in hardcopy form in the BEFS files. Taxonomic, physicochemical and bacteriological data are summarized in annual program activity reports. These

reports are distributed to KDHE district offices, county conservation offices, Kansas Department of Wildlife and Parks staff, and other interested organizations and individuals.

Data reported to program staff on standardized laboratory reporting forms are carefully reviewed for obvious errors or omissions. Information derived from QC samples (duplicates, spikes, blanks, etc.) are subjected to particularly thorough review. With the approval of the program manager, data that are deemed inaccurate, or grossly unrepresentative, are purged from the electronic database prior to transfer to STORET (see section 4.8.2, below). Redundant forms of data storage and backup (e.g., EPA STORET system, Kansas Water Database, KHEL tape files, BEFS hardcopy files) help to ensure the long-term integrity and availability of the program data.

Each lake, and each sampling station on a lake, is assigned a unique six-digit identification number or "code" for entry onto the STORET system. These STORET codes range from 010000 to 090000. The first four digits identify the particular lake, while the last two digits identify the station type and number. Digit five is the station type. Station codes utilized on the STORET database are described below:

0 = primary open water station;

1 = station on stream entering lake or wetland;

2 = station on stream exiting lake or wetland;

3 = point source discharge within the watershed (can be natural, such as a spring discharge, or artificial, such as a wastewater treatment plant discharge);

4 = discharge water quality of smaller impoundment within watershed;

5 = open water samples collected at a KDHE lake or wetland station by another participating agency, university, etc. ("01" would be identical in location to "51", but "51" would indicate the sample was collected by a monitoring entity other than KDHE);

6 = stream samples collected at a KDHE station by another participating agency, university, etc.

7 = runoff event data collected from a KDHE station on a stream entering a lake or wetland;

8 = runoff event data collected from a KDHE station on something other than a stream entering a lake or wetland; and

9 = miscellaneous information (rainfall data, etc.).

Digit number six identifies the number of stations for each type. Station number "1" is normally closest to the dam, and station numbers increase with distance upstream of the dam. Likewise, stream stations assigned the number "1" are normally closest to the point where a major stream enters a lake or wetland, and numbers become greater with distance upstream. Stations on a stream exiting a lake or wetland are assigned numbers in the reverse order (i.e., higher station numbers are indicative of increasing distance below the waterbody). In most cases, however, only a single KDHE station occurs downstream of a monitored lake or wetland.

The following examples demonstrate the proper use of this coding system. For lake 0350 (Hillsdale Lake in Miami County), the primary open water station would be 035001. The first stream station on Big Bull Creek would be 035011. The first identified point source discharge where data is collected would be 035031 (City of Gardner's wastewater treatment plant). Stations where runoff events are sampled, other than stream stations, would be assigned numbers ranging from 035081 to 035089. Individual sampling points may have STORET data under more than one name, due to inclusion in different KDHE programs for different purposes. The aforementioned coding system is used only for lake/wetland related projects.

4.8.2 Data Entry Requirements

Environmental data (and metadata) manually entered into an electronic database by program staff are examined and verified at least annually by the program manager. This process entails the selection of a representative, randomly selected sample of data and the documentation and correction of any data entry errors. This sample generally comprises 5-10 percent of the data collected during the preceding year. Staff transferring or receiving data electronically perform random spot checks of the data and report any problems to OIS for further investigation and resolution. Persistent problems are reported to the section chief and bureau QA representative for consideration of necessary corrective actions.

4.8.3 Verification of Calculations

Computer-based mathematical, statistical, graphical and geographical programs and models involving environmental data are tested before application by comparison to other computer programs, through hand calculations involving randomly selected data, or through other appropriate means. The reliability of these models and programs is reexamined on at least an annual basis or whenever a problem is reported within a computational system. Quattro Pro, Excl, PC SAS, AGNPS and EUTROMOD are among the forms of software used for generating spreadsheets, graphs and models or for performing statistical characterizations, comparisons and trend analyses.

4.8.4 Data Transformation, Outliers and Reporting Limits

Many forms of environmental data do not conform to a normal distribution and may necessitate the use of nonparametric statistical methods. Alternatively, the data may be transformed statistically to induce a normal, log normal or some other preferred data distribution. In general, data are first graphed to reveal the general shape of the distribution and to help identify the most appropriate transformation procedure. Commercially available computer programs may be applied in more detailed assessments of data distribution. PC SAS software maintained on one of the BEFS desk top

computer offers several algorithms for characterizing departure from normality (e.g., Shapiro-Wilk and Kolomogorov tests available through the UNIVARIATE procedure).

Water quality data occasionally may include anomalous values or statistical outliers. Obvious outliers (those that are orders of magnitude beyond any reasonable value) often constitute data transcription errors or measurement unit conversion errors. In other instances, outliers may reflect the gross contamination of samples, analytical errors, or an actual (though rarely occurring) fluctuation in water quality. In the lake and wetland water quality monitoring program, data are automatically questioned by staff if reported duplicate concentrations vary by more than 30 percent or if a value is outside the historical range for the parameter and waterbody in question. If follow-up consultations with field, laboratory, and data management personnel provide no reasonable explanation for a questionable value, the program manager may either flag the value or delete the value from the database.

Parameter concentrations that are less than the applicable minimum reporting limit (MRL) established by KHEL tend to complicate data analysis. Although a hypothetical value of one-half the MRL may be assigned to facilitate statistical examination, the MRL itself, or a value of zero, may be more appropriate in some applications. Concentrations of fecal coliform bacteria are occasionally reported as greater than the applicable upper reporting limit. In such instances the upper reporting limit may be assigned in place of a known concentration, and any computed average or related statistic given a “greater than” designation. Nonparametric procedures based on rank-order or percentiles tend to be less effected by these kinds of data and are often favored by staff performing statistical characterizations, comparisons and trend analyses.

4.8.5 Ancillary Data

Ancillary data used in this program may include hydrological, meteorological, or biological data derived from other state or federal agencies. An effort is made to ensure that these agencies have appropriate QA plans in place. In some instances, these agencies collect data under contract to KDHE, or under the auspices of an EPA grant, both of which require development and approval of a QAPP prior to data collection (see QMP, Part I, section 2.3).
Pollutant loading coefficients and some other values applied in modeling calculations are taken from documents produced by governmental agencies or from literature sources incorporating peer review of articles before publication. Staff carefully examine the underlying technical assumptions before applying these coefficients and values in the lake and wetland water quality monitoring program.

4.9 Quality Assurance Reporting Procedures

End-of-year program evaluations are conducted by the section chief and a written report submitted to the bureau QA representative, bureau director and divisional QA officer by February 15 of the following year. The program manager cooperates in the evaluation of QA/QC performance and makes available all records pertaining to the precision, accuracy, representativeness and comparability of the monitoring data gathered during the course of the evaluation period. Program evaluations prepared by the section chief indicate when, how, and by whom the evaluation was conducted, the specific aspects of the program subjected to review, a summary of significant findings, and technical recommendations for necessary corrective actions. The section chief

discusses the reported findings with the program manager and other participating field, laboratory and data management staff.

4.10 Purchased Equipment and Supplies

When newly ordered or repaired sampling, analytical or computational equipment is delivered to the program office, the program manager (or his designee) compares the item to that requested on the original order, then inspects the equipment to ensure no breakage has occurred in transit and all components function properly. Once this inspection is completed, the manager (or designee) either accepts or rejects the shipment.

Office and laboratory supplies receive a comparable level of scrutiny. Reference standards and equipment (e.g., chlorophyll-a standards; NBS-traceable thermometers) must be accompanied by a certificate from the vendor or manufacturer verifying the quality of these products.

4.11 Program Deliverables

Lake and wetland water quality monitoring program reports are prepared annually by the program manager. Each report summarizes that year's sampling activity and compares documented water quality conditions to applicable regulatory criteria/guidelines and past findings. These reports are produced as a service to the interested public and as a source of information to other water-related agencies. Draft reports are subject initially to review and comment by section staff. After consideration of these comments, the report is amended by the program manager and routed to the section chief and bureau director for final approval. Given the level of data analysis and the time required for review and printing of the report, publication may lag as much as twelve months behind the completion of the data collection effort. Other deliverables include electronic databases, illustrative materials, and statistical water quality summaries used in a variety of agency applications. These deliverables are updated at least annually.

Section 5

REVIEW AND REVISION OF PLAN

To ensure that QA and QC activities meet the evolving needs of the lake and wetland water quality monitoring program and remain consistent with the primary goal established in section 2, all portions of this plan and appended SOPs are reviewed by the program manager and program staff on at least an annual basis. Revisions to the plan and SOPs require the approval of the program manager, section chief and bureau QA representative prior to implementation. Although review activities normally occur after the completion and submission of the annual program evaluation in February, revisions to the plan and SOPs may be considered at any time based on urgency of need or staff workload considerations.

Original approved versions of the QA management plan and appended SOPs, and all original historical versions of these documents, are maintained by the bureau QA representative or his/her designee. The bureau QA representative also maintains an updated electronic version of the plan and SOPs on the KDHE internet server in a "read only" PDF format.

APPENDIX A

INVENTORY OF FIELD AND LABORATORY EQUIPMENT

INVENTORY OF FIELD AND LABORATORY EQUIPMENT

I. VEHICLE

A. 1995 Ford Club Wagon Van (with heavy duty towing hitch for boat trailers)

II. BOATS

A. Tracker Marine Corporation 18-ft pontoon boat (with 60-hp outboard motor and MotorGuide electric trolling motor)

B. Lowe Industries 14-ft Jon boat (with 9.9-hp Evinrude outboard motor)

III. GENERAL FIELD EQUIPMENT

A. Equipment/supplies routinely carried in van

1. Kemmerer sampler bottle with graduated rope
2. Life vests and flotation cushions
3. Raincoats
4. Stream sampling bucket and ropes
5. Stainless steel pail and funnel
6. Tool kit and jumper cables
7. First aid kits, emergency eye wash bottles, and fire extinguishers
8. Secchi disk with graduated rope
9. Weighted, graduated rope for measuring water depth
10. Plastic bags for macrophyte samples
11. Grapnel hook and rope for macrophyte surveys
12. Ice chests
13. Reagents for Winkler DO samples and nutrient samples
14. Lugol's preservative and syringe

15. Sample containers (including pesticide jugs, nutrient bottles, heavy metal bottles, cubitainers, DO bottles, algal bottles, and any additional bottles required for special samples)

16. Water proof markers and pencils

17. Metal clipboard (holding data recording forms, sample submission forms, current boating regulations, macrophyte field key, etc.)

18. Plastic dispensing bottles containing distilled water or ASTM Type-I quality water, including water supplies for any blank and/or spike samples being prepared for a given sampling trip

19. State and county maps

20. Extendable pole sampler

21. Hand disinfectant and paper towels

22. Camera and slide film

23. Vehicle credit card and log book

24. Light meter with graduated depth cable

B. Additional equipment/supplies carried in van during special investigations

1. Hand field pump for filtered samples

2. Gelman glass-fiber filters

3. Zooplankton tow net and graduated rope for depth-integrated zooplankton tows

4. Plastic dispenser bottle containing ethanol preservative for zooplankton samples
5. Ponar dredge

6. Any special sample containers needed to conduct investigation

C. Equipment/supplies carried in pontoon boat or on trailer

1. Key

2. Sufficient fuel and oil in reservoirs

3. Fully charged battery

4. Trolling motor

5. Oars

6. Sonar depth finder

7. Spare tire

8. Anchor and line

9. First aid kit and fire extinguisher

D. Equipment/supplies carried in Jon boat or on trailer

1. Sufficient oil/fuel mixture in tank

2. Oars

3. Spare tire

4. Boat plug

5. Anchor and line

6. First aid kit and fire extinguisher

IV. MEASUREMENT APPARATUS

A. Field apparatus

1. Fisher model #15-0778 stainless steel dial scale thermometer (-10 to +110 ^{o}C)

2. YSI model #51B dissolved oxygen meter (with YSI combination thermistor/O_2 membrane probe), cable and carrying case

3. Cole-Parmer model #5996-80 portable pH meter (LCD readout with instruction manual, carrying case, combination pH probe, AC adapter, and pH 4, 7, and 10 buffer solutions)

4. Li-Cor model LI-250 digital light meter with LI-193SA spherical underwater quantum sensor, cable, and carrying case

B. Apparatus in BEFS shop/laboratory

1. Milton-Roy "Spectronic 501" ultraviolet/visible spectrophotometer

2. Wild Heerbrugg model M40 inverted microscope with Sedgwick-Rafter counting cell

APPENDIX B

STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

Procedure	Revision No.	Date
Maintenance and Calibration Procedures for Field Analytical Equipment (LWMP-001)	0	12/01/00
Procedures for Field Analytical Measurements (LWMP-002)	0	12/01/00
Procedures for Collecting, Preserving and Transporting Lake and Wetland Water Quality Samples (LWMP-003)	0	12/01/00
Chain-of-Custody Procedures for Lake and Wetland Water Quality Samples (LWMP-004)	0	12/01/00
Laboratory Analytical Procedures for Lake and Wetland Water Quality Samples (LWMP-005)	0	12/01/00
Vehicle Safety and Maintenance Procedures (LWMP-006)	0	12/01/00
Boat Winterization and Trailer Maintenance Procedures (LMWP-007)	0	12/01/00

MAINTENANCE AND CALIBRATION PROCEDURES FOR FIELD ANALYTICAL EQUIPMENT (LWMP-001)

I. INTRODUCTION

A. Purpose

This document describes the procedures used to ensure the proper and reliable operation of field measurement apparatus used in the lake and wetland water quality monitoring program.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the chemical and physical properties of surface water and have a basic technical understanding of the associated measurement apparatus.

C. Thermometer Specifications

Manufacturer:	Fisher
Instrument type:	Dial scale thermometer
Model number:	15-0778
Range:	-10 to 110 degrees Celsius
Resolution:	1.0 degree Celsius

D. pH Meter Specifications

Manufacturer:	Cole Parmer
Instrument type:	Portable digital pH meter
Model number:	5996-80
Range:	0-14 pH units
Resolution:	0.01 pH units

E. Dissolved Oxygen Meter Specifications

Manufacturer:	YSI
Instrument type:	Portable temperature/DO meter
Model number:	51B
Range:	-5 to 45 ^{o}C, 0-15 mg DO/L
Resolution:	0.5 ^{o}C, 0.1 mg DO/L

F. Light Meter Specifications

Manufacturer:	Li-Cor
Instrument type:	Portable light/quantum meter
Model number:	LI-250 digital meter
	LI-193SA underwater spherical quantum sensor
Range:	1 to >10,000 umol/s/m^2
Resolution:	1 umol/s/m^2

II. PROCEDURES

A. Fisher Dial Scale Thermometer

Procedures described in SOP No. GQMP-003.II.C are adopted by reference.

B. Cole Parmer pH Meter

Procedures described in SOP No. GQMP-003.II.A are adopted by reference.

C. YSI Dissolved Oxygen Meter

1. At the beginning of each sampling season, replace the probe membrane and batteries. Afterwards, the meter is checked against Winkler wet-chemistry for accuracy. The dissolved oxygen readings should be within 0.5 mg/L of the Winkler readings.

2. Immediately prior to each use, check the meter battery level at zero- and full-scale settings.

3. The meter is air-calibrated, using a probe chamber with a near 100% saturated atmosphere according to manufacturers instructions. The calibration is relative to the elevation of the sampling location, taken from state highway maps or USGS topographic maps.

4. After calibration, the probe is freed from the calibration/storage chamber and placed in the water to be measured.

5. A Winkler sample is collected from the water surface for later comparison to the meter reading. This procedure helps identify the need for any meter maintenance during the sampling season. If problems are encountered, procedure II-C-1 is repeated. If necessary, the meter and/or probe are sent to the manufacturer for repair.

6. After use, the probe is placed back in its calibration storage chamber and the meter is turned off. For short storage periods (e.g., time required to travel to next lake) the chamber may be filled with distilled water or with lake water that is low in suspended solids. For long-term storage, the chamber should be rinsed and filled with distilled water. The chamber should be filled with about 1.0 inch of water, enough to maintain near 100% humidity within the chamber.

D. Li-Cor Light/Quantum Meter

1. At the beginning of each sampling season, the batteries are replaced and the calibration constants (loaded in the meter's memory) are checked.

2. At the time of use the meter is first checked against the air calibration value and a reading is taken above the air/water interface.

3. The meter is then lowered to just below the air/water interface, and checked using the underwater calibration value. If either calibration value is off, the screw adjustment, located on the back, is used to re-calibrate the meter.

4. Light intensity (photosynthetically active radiation only) is measured at one-meter depth intervals until that depth is reached where it is reduced to approximately one percent of the surface light intensity.

5. The meter and probe are allowed to dry before sealing the storage box, and the meter is detached and stored in its own sealed box to prevent moisture interfering with the meter.

PROCEDURES FOR FIELD ANALYTICAL MEASUREMENTS (LWMP-002)

I. INTRODUCTION

A. Purpose

This document describes the procedures used by program staff to measure lake/wetland temperature, pH, light, and DO levels *in situ* or in water samples collected from discrete depths.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the chemical and physical properties of surface water and have a basic technical understanding of the associated measurement apparatus.

C. Equipment/Accessories

1. Fisher model 15-0778 stainless steel dial scale thermometer.

2. Cole Parmer model 5996-80 portable pH meter (instruction manual, case, LCD readout, combination pH probe, and pH probe buffer solutions (pH 4, 7, and 10).

3. YSI model 51B dissolved oxygen meter (combination thermistor/O_2 membrane probe, depth marked cable).

4. Li-Cor light/quantum meter, model LI-250, with an underwater LI-193SA spherical quantum sensor and depth marked cable.

II. PROCEDURES

A. Thermometer

Procedures described in SOP No. GQMP-004.II.A are adopted by reference.

B. pH Meter

Procedures described in SOP No. GQMP-004.II.B are adopted by reference.

C. Dissolved Oxygen Meter

1. Calibrate the meter as per the instructions in SOP No. LWMP-001.II.C and the manufacturers guidelines. Once calibrated against elevation, the probe is freed from the calibration/storage chamber and placed in the water to be measured. The meter is switched from "calibrate" to "temperature."

2. Place probe just beneath surface of water. Temperature readings are made at this depth (0.0 meter), at 0.5 meter, and at each full meter depth below the surface. Record values on appropriate field sheet (Form App.C-1). When final reading is made, switch instrument to DO mode for probe's return pull to the surface.

3. The temperature selector dial is adjusted to the temperature recorded at the final depth. After this adjustment, the concentration of dissolved oxygen is read from the display and recorded for that depth.

4. The probe is then raised to the depth of the previous temperature reading, the temperature selector dial is adjusted to that temperature, and steps 3 and 4 are repeated until the final dissolved oxygen reading is taken at 0.0 meters.

5. Once measurements are completed, turn off meter, coil cable back onto spool, and place probe back into the calibration chamber for storage. After this is completed, collect Winkler sample from just beneath the surface (0.0-meter depth) for later comparison to the surface oxygen meter reading.

D. Light/Quantum Meter

1. After calibrating meter, as per LWMP-001.II.D, the meter readings just below and above surface are recorded on the appropriate field sheet (Form App.C-1).

2. Subsequent readings are taken by lowering the probe to discreet 1 meter intervals, and recording the values at those depths, until the value falls below 1% of the value just below the air/water surface.

3. After the final reading is recorded, the probe is retrieved and the meter is detached from the cable. The probe and cable are placed in the instrument storage container. The meter is further sealed in its own water-tight storage box to prevent humidity from interfering with subsequent readings at the next site. To prevent rust/corrosion on any metal surfaces and connections, the probe and cable should be allowed to dry completely before the storage box is sealed for long term storage.

PROCEDURES FOR COLLECTING, PRESERVING AND TRANSPORTING LAKE AND WETLAND WATER QUALITY SAMPLES (LWMP-003)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the procedures for the collection, preservation, and transport of lake/wetland water quality samples.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the physicochemical and microbiological properties of surface water and in the performance of environmental field investigations.

C. Equipment/Accessories

1. Kemmerer water collection bottle (2.5-liter capacity) with brass messenger and 50 meters of marked depth line

2. Appropriate sample collection bottles, reagents

3. Stainless steel bucket and rope, extendable pole sampler, and Secchi disk with marked depth line, plant grapnel and line

II. PROCEDURES

A. Once the boat is anchored over the sampling location, the Kemmerer is rinsed in surface lake water repeatedly.

B. The bottle is locked into the open position and lowered to a depth of 0.5 meter. The brass messenger is used to close the bottle, which is brought to the surface.

C. Water is discharged into the first set of sample bottles via the discharge nipple located at the bottom plunger of the Kemmerer bottle. The first set of "surface" samples includes a nutrient sample, a bacteria sample, a heavy metal sample, a one-liter cubitainer for mineral analyses, and a one-liter cubitainer for chlorophyll-a analyses.

D. Steps B-C, above, are repeated for the collection of the duplicate set of surface samples.

E. After determining the maximum depth at the station using a weighted, calibrated depth line, lower the Kemmerer in the open position to a depth 0.5-1.0 meter above the bottom sediment.

F. The messenger is used to close the bottle, then the sample is brought to the surface. A small amount of water should be released from the discharge nipple to ensure the nipple is free of any sediment. Dispense water from the Kemmerer bottle into the appropriate collection bottles, as was done for the surface samples. This first set of "bottom" samples includes a nutrient sample, a heavy metal sample, and a one-liter cubitainer for mineral analyses.

G. Collect a duplicate bottom sample by repeating steps E-F, above.

H. Other water quality samples are collected as follows: Pesticides are collected just prior to the first set of surface chemistry samples by holding the 1 gallon glass jug at arms length under the surface until it fills. Algae samples are collected at the same time by holding the brown, plastic bottle at arms length under the surface until it fills. While most lake and wetland program samples are collected in duplicate on a routine basis, pesticides are not. The primary reason for this is existing laboratory capacity and costs. Pesticide duplicates are collected at only 10 percent of the waterbodies sampled by staff. Collection procedures for the duplicate pesticide samples are identical to those of the primary samples. Duplicate samples are collected roughly five minutes after the collection of the primary samples.

I. During complaint investigations, or when boat access is restricted, samples may be collected from the dam face using either the extendable pole sampler or the stainless steel bucket. Only samples near the surface can be obtained using this technique, and either sampling device must first be rinsed with surface water several times before collecting a sample.

J. Secchi disk depth is measured as per the description in section 4.2.3 of the LWMP QAMP. A Winkler DO sample is collected at the surface, primarily as a check against the calibration of the DO meter. The sample must be collected with a minimum of agitation, and the bottle must have no air bubbles once the cap is in place. This concludes water quality data collection at the primary lake station. It is during this time that temperature/DO/light profiles are also measured.

K. If the lake has a surface area of less than 250 acres, and has not had a previous macrophyte survey, then macrophyte sampling is commenced prior to returning to shore. Other water samples are placed in a dark (or deeply shaded) location while this activity proceeds. Between 10-20 sampling locations, scattered evenly across the

lake and previously plotted on a small map, are assessed for the presence of macrophytes. Macrophytes in this case are limited to submersed and floating-leaved vascular plants. The boat is maneuvered to the vicinity of each of these 10-20 locations to assess the presence of macrophytes. Field staff conduct visual searches for macrophytes at each location, and a grapnel hook is towed along 5-6 meters of lake bottom, retrieved, and inspected for any snared plants. Presence or absence of macrophytes, plus presence/absence of individual species, is recorded on the form App.C-3. Specimens that cannot be identified in the field are transferred to ziplock polyethylene bags, stored out of direct sunlight, and later transferred to the BEFS laboratory facility for closer scrutiny (see step M, below).

L. Upon completion of the above activities and return to shore, one staff member deals with the sample preservation while the other prepares the boat and equipment for transport to the next site. The first act upon returning to shore is to start the standardization of the field pH meter. While the pH meter is being standardized, the Winkler dissolved oxygen sample has reagent #1 (manganous sulphate) and #2 (alkaline potassium azide iodide) added. The Winkler sample is then set aside.

M. Nutrient samples are preserved by adding 1 ml of 1:30 v/v sulfuric acid solution, then stored on ice in darkness (i.e., ice chest) in a secure location inside the van. Heavy metal samples containing nitric acid preservative do not require storage on ice but must be securely stored for transport. The algal sample is preserved by adding 1.5 ml of Lugol's iodine and packed away for transport in a cool, shaded location inside the van. All macrophyte specimens, bacteriology bottles, pesticide samples, and cubitainers are packed on ice, with the temporary exception of the "surface" and "bottom" cubitainers used for pH analysis.

N. The pH meter should now be ready for measuring the pH of aliquots from the surface and bottom cubitainers (see step L, above, and SOP No. GQMP-004.II.B). pH values are recorded (form App.C-1) and the four cubitainers are stored in the ice chest.

O. Paperwork is checked for completeness and accuracy, and the van contents and boat are checked for transport readiness (LWMP-006). One ml of concentrated sulfuric acid is added to the Winkler DO sample, and the sample is capped, inverted repeatedly, and stored in a secure, shaded location inside the van. Survey activities at this site are now complete, and the sampling crew may move on to the next survey location.

P. On occasion, conditions on-site do not allow a boat to be safely put on the water. If conditions are such that a full water quality survey cannot be conducted, but a return to the location at a later date is not feasible, then staff have the option of conducting an abbreviated survey. An abbreviated survey will collect water quality samples off the outlet tower (larger lakes) or via tows with a stainless steel sampling bucket and

rope conducted from the face of the dam or a courtesy dock located near the dam. If an abbreviated survey cannot be conducted so that samples will be representative of the main body of an impoundment, the survey must be reschedule. An abbreviated survey entails measurement of water temperature and collection of duplicate samples for nutrient, mineral, heavy metal and chlorophyll-a analysis, a pesticide sample, a surface Winkler DO sample, phytoplankton samples, and bacteriological samples, all from a depth of about 0.5 meters. If the outlet structure permits, water column transparency is measured via Secchi disc. An abbreviated survey does not involve collection of information on water quality below 0.5 meter, temperature/dissolved oxygen levels, or macrophyte community structure.

Q. On rare occasions, depth integrated zooplankton samples and lake sediment samples may be required. Sediment samples are collected by locking the Ponar dredge into the open position, dropping it to the sediment (which automatically un-locks the dredge), and pulling the full dredge back to the surface. A sample of sediment is collected by emptying the dredge contents into a plastic tub rinsed with lake water, and using a nylon spoon to extract 200-300 cubic centimeters from the interior of the sediment sample. This aliquot of sediment is placed in glass jars specifically provided by KHEL and labeled accordingly.

Depth integrated zooplankton samples are collected using a standard zooplankton conical net with a detachable collection bucket at its apex. Vertical tows are collected by lowering the net on a calibrated line to the desired depth, waiting three minutes for the water column to re-equilibrate from passage of the net, and pulling the net to the surface. Lake water is splashed on the outside of the net to rinse adhered organisms into the collection bucket. The bucket is removed from the net, placed over an open, 100 ml screw-top glass jar, and the bucket plunger removed to allow transfer of contents into the jar. A squeeze bottle containing 70% ethanol is used to rinse remaining organisms from the bucket's interior into the collection jar. The jar is filled with ethanol solution (taking care to avoid overflow and loss of zooplankton specimens), the lid is securely screwed into place, and a label is attached to identify sampling date, time, location, collector, and the length of the vertical tow used to collect the sample. Identification and enumeration of specimens occurs later at the BEFS laboratory using established procedures (Wetzel and Likens 1979).

III. SAMPLE HOLDING TIMES[1]

Fecal coliform bacteria	24 hours
Biochemical oxygen demand, nitrate, nitrite, ortho-phosphate, turbidity	48 hours
Chlorophyll-a (time to filtering and freezing)	72 hours
(time from filtering/freezing to analysis)	4 months
Total suspended solids	7 days
Pesticides (time to extraction), total organic carbon, alkalinity	7 days
Pesticides (time from extraction to analysis)	40 days
Mercury	13 days
Heavy metals (other than mercury) and metalloids	6 months
Ammonia, bromide, chloride, chemical oxygen demand, fluoride, Kjeldahl nitrogen, total phosphorus, sulphate, specific conductance, silica	28 days
Algae (without periodic renewal of Lugol's solution)	6 months

[1]Indicated holding times assume samples are held under appropriate environmental (e.g., pH, temperature, light) conditions (see APHA 1992)

CHAIN-OF-CUSTODY PROCEDURES FOR LAKE AND WETLAND WATER QUALITY SAMPLES (LWMP-004)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the procedures for the proper accounting and routing of water quality samples collected during lake and wetland monitoring operations.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration.

II. PROCEDURES

A. All samples submitted to KHEL for analysis must be accompanied by an appropriate sample submission form (Appendix C). This includes water quality samples for minerals, nutrients, heavy metals, bacteriology, and pesticides and any sediment samples or other special samples analyzed by KHEL. At the bottom of each sample submission form are fields for chain-of-custody. The first field is signed by one member of the field crew that collected the samples in question. On the date the samples are delivered to KHEL, this person must sign/date the first chain-of-custody field using indelible ink. Upon delivery, staff of KHEL will accept the samples and sign/date the second chain-of-custody field using indelible ink. This provides a record of custody from the time of collection to the time of arrival at KHEL. Photocopies of these forms are made immediately after signatures are obtained. The original forms are retained by field staff for routing to the program manager; photocopies are left with the KHEL personnel receiving the samples.
In the unlikely event that samples pass through more than one transfer, additional chain-of-custody fields are filled out on sample submission forms. The KHEL forms supply three sets of fields on each form. Each time a person takes or relinquishes responsibility for the samples, he/she must fill out a chain-of-custody field on each separate submission form.

B. Chlorophyll-a and dissolved oxygen samples are analyzed by program staff at the BEFS laboratory facility. Personnel identified as crew members on the field sheet (Form App.C-1) are responsible for the safe transport and proper analysis or storage of these samples (see SOP No. LWMP-003.III and -005). Crew members should be

able to account for the security and integrity of the samples from the time of collection to the time of analysis or storage. If these samples must be transferred to some other party en route to the BEFS laboratory facility in Topeka, then the individuals relinquishing and those receiving the samples must each sign the bottom of the field sheet and indicate the date, time and location of sample transfer.

C. Forms completed in the field contain important empirical data and supporting documentation. Loss of these forms, or any accident which would impair their legibility, would result in a significant loss of data and could necessitate a return trip to the lake or wetland in question. Hence, it is imperative that care be taken by staff in the handling, filing and eventual archiving of these documents. Similar considerations apply to any photographs or other forms of documentation obtained during the course of field activities.

LABORATORY ANALYTICAL PROCEDURES FOR LAKE AND WETLAND WATER QUALITY SAMPLES (LWMP-005)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the procedures for the analysis of Winkler DO samples and chlorophyll-a samples collected by staff of the Kansas lake and wetland water quality monitoring program.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should be experienced in the measurement of the chemical and physical properties of surface water and in the analysis of chlorophyll-a samples..

C. Equipment/Accessories

1. Milton-Roy "Spectronic 501" UV/visible spectrophotometer
2. Wild Heerbrugg, model M40, inverted microscope and modified Sedgwick-Rafter counting cell, settling tubes
3. Chicago Surgical and Electrical Company safety angle centrifuge
4. Titration burette, titrant, starch solution
5. Tissue grinder, centrifuge tubes, forceps, vacuum filter manifold, 0.45 micron glass fiber filters
6. Fluorescent light banks, screw top jars, nutrient spike solutions
7. Li-Cor model LI-250 light meter with LI-193SA spherical quantum sensor

II. PROCEDURES

A. Winkler Dissolved Oxygen Titration

Once the treated and acidified DO sample is returned to the BEFS lab, it is titrated with sodium thiosulfate titrant (supplied by KHEL). The burette reservoir is kept wrapped with aluminum foil to prevent degradation of the titrant by ambient light.

1. Two hundred ml of the sample to be titrated is decanted into a dedicated 250-ml graduated cylinder. This volume is then poured into a 500-ml Erlenmeyer flask.
2. The burette cylinder is filled with titrant by manually pumping the attached bulb. The titrant level should correspond to the zero reading at the top of the cylinder before commencing tiration. While twirling the flask to thoroughly mix the contents, titrant is dispensed very slowly from the burette until the contents of the flask turn a pale, straw yellow.

3. One-to-two ml of starch solution are added to the flask, turning the contents blue. While gently twirling the flask, titrant is added very slowing until the solution finally losses all blue color. This can be determined by holding the flask up to a white object, such as a sheet of paper or a white wall.

4. At this point, the DO measure is read directly from the burette. The volume of titrant (in milliliters) required to invoke color change is equal the DO concentration (in mg/L) in the original water sample. The flask and cylinder are rinsed with distilled water between samples. Tap water cannot be used as the final rinse water because the free chlorine interferes with the Winkler titration.

B. Chlorophyll-a Determination

1. Chlorophyll-a samples must be processed within 72 hours of collection. The first step involves filtering the sample, using a Millipore filter manifold and Gelman type A/E glass fiber filters. Each sample consists of a one-liter cubitainer of lake water. All reasonable effort should be made to filter the entire liter, although samples with large amounts of algae or inorganic turbidity may make this impossible. A rule of thumb is to filter for a maximum of 10 minutes for each sample. Date of collection, collection site, and volume filtered are written on a label for each sample.

2. Once filtering is complete, the filter is folded twice and folded within a blotter paper. Standard paper towels work very well by tearing them in three equal pieces, for three blotter papers. The identifying label is taped to the sample, and the sample is placed (along with 7-9 other samples) in a whirl-pack plastic bag . The bag containing the samples is filled with dry-right pellets to facilitate dehydration. Sample packets should be interspersed among the dry-right pellets for maximum contact.

3. Place sealed whirl-packs in a freezer at -20^{O}C for at least three weeks.

4. After three weeks, but before 15 weeks, have passed, samples are taken out of the freezer for final analysis. Each sample is processed under reduced lighting conditions from this point onward. Each sample is placed in a glass tissue grinder mortar, along with 4-5 ml of 90 percent acetone and two drops of saturated magnesium carbonate suspension. After complete grinding, the mixture is decanted into a centrifuge tube. Residue is rinsed from the pestle and the mortar with 90 percent acetone, which is added to the centrifuge tube. Care should be taken to end up with 15 ml, or less, in each centrifuge tube.

5. Once the rinsing process is complete, the centrifuge tube is capped tightly, labeled with the lake name and sample number (e.g., Centralia Lake #1), and placed in a tube rack in the dark. All other pertinent information is transferred to the chlorophyll-a analysis form (App.C-4).

6. After a complete rack of samples (10-20) has been ground, the tube rack is placed in the refrigerator, under a light cover, for 24 hours.

7. Measurement of chlorophyll-a concentration follows the 24-hour extraction period indicated in step 6, above. Samples are placed in the centrifuge, taking care to correctly balance the centrifuge tubes in the machine to prevent breakage and bodily harm. Samples are centrifuged in groups of six (capacity of the centrifuge) at 3,400 rpm for approximately 20 minutes. For greater efficiency, processed groups may be analyzed spectrophotometrically as other groups are being centrifuged. The spectrophotometer should be allowed to warm up for 30 minutes before measuring the first group of samples.

8. A pipette is used to transfer 3 ml of each sample into a clean spectrophotometer cuvette. Each cycle of readings can accommodate four samples and a blank. The blank is composed of 100% acetone. Each sample is "read" at 750 nm and 663 nm, after the spectrophotometer is zeroed using the blank at each wavelength. After these two readings are complete, two drops of 0.1 N hydrochloric acid are added to each sample. After waiting 90 seconds, the samples are read at 665 nm and 750 nm. The readings at each wavelength are recorded on the chlorophyll-a analysis form (App.C-4), along with the volume in each centrifuge tube prior to removing the 3 ml aliquot.

9. After the four samples in the spectrophotometer rack are read at the four wavelength settings, they are emptied into a waste jar, rinsed with 90% acetone twice, allowed to dry for 2-3 minutes, polished externally with Kimwipes, and placed back in the rack. The rack is now ready for the next four samples.

10. After all samples in the run are analyzed, glassware is cleaned, dried and stored for the next run; machinery is turned off and dust covers placed in position; and data are run through calculations (APHA, 1992) to determine the corrected chlorophyll-a readings of each sample.

11. Calculations utilize the data recorded on the chlorophyll-a analysis form (App.C-4). These calculations are present on the program manager's computer in a LOTUS spreadsheet. Final chlorophyll-a values are recorded on this same sheet.

C. Algal Taxonomy

1. Preserved algae samples are settled upon return from the field. For each sample, a 100-ml aliquot is poured into a glass settling tube. The tube is then corked and labeled with the sample location. Tubes are left undisturbed for 1-2 weeks.

2. At the end of 1-2 weeks, the upper 80 ml of the sample is drawn off using a vacuum hose. The remaining 20 ml of concentrated sample is resuspended and poured into a labeled 25-ml glass vial for long-term storage. Settling tubes are then rinsed and left to dry.

3. When counting algae in a sample, the glass vial is shaken and a sub-sample is placed into the microscope counting cell. The sub-sample should completely fill the counting cell. This is left to settle for about 5 minutes. All genera of algae are counted in 50 fields, selected randomly across the cell. A field is defined by the grid field in the microscope ocular.

4. Once 50 fields have been enumerated, the cell count can be calculated for each taxon using pre-calculated conversion factors. For example, in a sample concentrated five-fold, the cell count in 50 fields at 400X magnification is multiplied by 63 to yield the number of cells/ml.

5. Biovolume is calculated by estimating the mean cell volume for each identified taxon. This average value is multiplied by cell count/ml to generate biovolume in cubic millimeters/ml, ppm, etc. Identified taxa and cell counts are recorded on the automated algal taxonomic data sheet (Form App.C-5).

D. Nutrient Limiting Algal Bioassay

1. On occasion, it is of value to empirically determine the growth limiting nutrient or factor for the phytoplankton community. A five-gallon carbuoy, having been rinsed repeatedly with tap and then distilled water prior to use,

is rinsed at the lake in question with ambient water. A similarly rinsed one-gallon jug is used to fill the carbuoy with lake water collected from a depth of 0.5 meter.

2. After filling with lake water, the carbuoy is placed in a secure, heavily shaded location inside the van for transport to the BEFS laboratory. It is not chilled with ice or refrigerated, as the change in temperature would potentially damage some of the more fragile algae.

3. The carbuoy of water should be utilized within 24 hours of collection to set up the limiting bioassay.

4. Prior to going to the field to collect water, the bioassay laboratory should be made ready to receive the sample and conduct the bioassay. Staff should ensure that the fluorescent lights work properly and that the screw top jars have been cleaned using phosphate free detergent, rinsed repeatedly with distilled water, thoroughly dried, and appropriately labeled. Jars are dedicated to the type of experimental treatment they will receive, for the entire useful life of the jar.

5. Once the bioassay water is returned to the BEFS laboratory, the carbuoy is inverted 8-10 times to thoroughly mix the contents. Each of five jars (one for each experimental treatment) is filled with 800 ml of lake water. This sequence is repeated until five sets of five jars have been filled. The five treatments, each with five replicates, include control, high light treatment, nitrogen added, phosphorus added, and nitrogen plus phosphorus added.

6. Once the jars are filled with lake water, 1 ml of nitrogen stock solution is added to those jars receiving added nitrogen, and 1 ml of phosphorus stock solution is added to those jars receiving added phosphorus. Stock solution concentrations are such that the final concentrations of nitrogen and phosphorus in experimental treatments are roughly five times those in the controls.

7. Light banks are adjusted to simulate light conditions measured in the upper meter of the lake at the time of sample collection. A double set of fluorescent lights sandwiches a double row of 10 jars (20 jars total), with a white styrofoam barrier between the two rows. The last set of five jars (the high light treatment) is sandwiched in a row between two banks of lights with no intervening styrofoam partition; these jars receive 2-3 times the light of the other treatments. Jars in the various rows are positioned randomly. Light level is adjusted by using one, or both, of the lights in each of the banks, by adjusting distance between the lights and jars, and by confirming actual light levels in the samples with the Li-Cor light meter/quantum sensor.

8. Lids are placed very loosely on each jar to accommodate air interchange. Light banks are connected to a timer device which has been set to simulate the day/night cycle occurring on the date of sample collection. A fan is set up in the bioassay room to maintain uniform air temperature and prevent the jars from heating excessively.

9. Twice each day (excluding weekends when staff are not present), the jar lids are screwed on tightly, each jar is shaken gently for ten seconds, and the 4 jars in the middle of each row (for the main light bank set up) are cycled to the ends of the rows. This is done because light intensity varies slightly along the length of each bulb. For the high light set up, the process is the same except that the five jars are randomly placed twice each day along the middle portion of the light banks. Remember to loosen all jar lids at the end of this procedure.

10. The bioassay continues in this manner for 9-10 days or until heavy algal growth begins to impede light transmission in one or more of the experimental treatments. At the end of the bioassay, each jar is shaken vigorously to dislodge any attached algae from the walls of the container. If needed, a nylon spatula may be used to scrape off the attached algae. This spatula is cleaned in distilled water before repeating the process in another jar.

11. The 25 water samples, thus obtained, are analyzed for chlorophyll-a concentration (SOP No. LWMP-005.II.B). All bioassay glassware should then be cleaned in phosphate free detergent, rinsed repeatedly in distilled water, allowed to dry thoroughly, and put in storage until the next bioassay is scheduled.

VEHICLE SAFETY AND MAINTENANCE PROCEDURES (LWMP-006)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the standard vehicle safety and maintenance procedures used during the collection and transportation of lake and wetland water samples. Safety procedures are established to prevent or minimize property damage, personal injuries, and/or loss of life. Maintenance procedures are established to prevent or minimize vehicle breakdowns and to extend the useful life of program vans and boats.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration. They also should possess a valid Kansas driver's license and current certifications in both standard first aid and cardiopulmonary resuscitation (CPR). Although not required, these employees are strongly encouraged to participate in defensive driving courses and boating safety courses offered by certain governmental agencies and other qualified organizations.

C. Equipment/Accessories

1995 Ford Club Wagon Van, with spare tire and tire changing equipment, emergency road reflectors or road flares, mounted emergency flashing lights, fire extinguisher, first aid kit, emergency eye wash station, flashlight, windshield ice scraper, heavy duty towing hitch, oversized side-view mirrors, cellular telephone, AM/FM radio

Tracker Marine Corporation 18-ft pontoon boat, 60 hp outboard motor, battery-operated trolling motor, back-up oars, sonar depth finder, battery-operated anchor winch, deck awning, safety rails and sampling hatch, emergency running lights, air horn, fire extinguisher, life vests, floatation cushions, first aid kit, emergency flares, flashlight

Lowe Industries 14-ft Jon boat, with towing trailer, spare trailer tire and tire changing equipment, 9.9 hp outboard motor, back-up oars, life vests, floatation cushions

II. PROCEDURES

A. 1995 Ford Club Wagon Van

Procedures described in SOP No. GQMP-002 are adopted by reference.

B. Tracker Marine Corporation Pontoon Boat

1. All manufacturers guidelines concerning weight and passenger capacity shall be followed.

2. Staff shall become familiar with current boating safety rules and regulations before operating boat. Staff are encouraged to attend boating safety courses offered each year through the Kansas Department of Wildlife and Parks and/or the United States Coast Guard.

3. Staff should periodically (every 2-3 hours of motor operation) check fuel, oil, and battery levels.

4. Staff should visually check trailer condition, trailer tire condition, strap-downs, and trailer lights at the beginning of each day in the field. Before launching boat, staff should ensure all applicable safety equipment is on board and functioning properly.

5. The outboard motor should never be operated out of the water.

6. Life vests must be worn at all times while on the water, not just while in transit to the sampling station or while returning to shore.

7. Most boat maintenance is the result of specific problems that occur during field operations. However, routine maintenance should be conducted by a reputable firm, or by knowledgeable BEFS staff, at the close of each sampling season. This "winterization" should include any required fuel additives for winter storage, check-out of the top and bottom units in the outboard motor, check-out of the trailer wheel bearings, and any other procedures recommended by the manufacturer. See LWMP-007.

C. Lowe Industries Jon Boat

1. All manufacturers guidelines concerning weight and passenger capacity shall be followed.

2. Staff shall become familiar with current boating safety rules and regulations before operating boat. Staff are encouraged to attend boating safety courses offered each year through the Kansas Department of Wildlife and Parks and/or the United States Coast Guard.

3. Staff should periodically (every 2-3 hours of motor operation) check fuel/oil level.

4. Staff should visually check trailer conditions, trailer tire condition, strap-downs, and trailer lights at the beginning of each day in the field. Before launching boat, staff should ensure all applicable safety equipment is on board and functioning properly.

5. The outboard motor should never be operated out of the water for more than a few seconds (sometimes required for trouble shooting in the field).

6. Life vests must be worn at all times while on the water, not just while in transit to the sampling station or while returning to shore.

7. Most boat maintenance is the result of specific problems that occur during field operations. However, routine maintenance should be conducted by a reputable firm, or by knowledgeable BEFS staff, at the close of each sampling season. This "winterization" should include addition of required fuel additives for winter storage, check-out of the top and bottom units in the outboard motor, check-out of the trailer wheel bearings, and any other procedures recommended by the manufacturer. See LWMP-007.

BOAT WINTERIZATION AND TRAILER MAINTENANCE PROCEDURES (LWMP - 007)

I. INTRODUCTION

A. Purpose

The following paragraphs describe the boat winterization and trailer maintenance procedures completed at the end of each sampling season and just prior to winter storage. Winterization and trailer maintenance procedures are established to minimize equipment breakdowns and extend the useful life of the boats, motors, and trailers used in the lake and wetland monitoring program.

B. Minimum Staff Qualifications

Personnel implementing this SOP should meet the minimum classification requirements for environmental technician II published by the Kansas Department of Administration.

C. Equipment/Accessories

Tracker Marine Corporation 18-foot Pontoon Boat and trailer

Lowe Industries 14-foot Jon Boat and trailer

60 Horsepower Tracker Pro Series Evinrude Motor

9.9 Horsepower Evinrude Motor

Tools as appropriate to complete procedures.

II.. PROCEDURES FOR WINTERIZATION

A. Tracker Marine Corporation Pontoon Boat

Prepare engine for winter storage by completing the recommended guidelines taken from the Operation and Maintenance Manual for the 60 hp Evinrude Motor as follows:

Motor:

1. To ensure proper water circulation through motor, attach Flush-Rite Muff flushing unit according to instructions on the box using caution to not use excessive water pressure. This unit is to be attached over the water intake openings while motor is being run for winterization.

2. To minimize condensation, fuel tanks should be filled and a gasoline stabilizer added. Follow manufacture's instructions on gas treatment container. Engine is then started and allowed to fast idle for approximately five minutes to distribute the stabilized fuel through engine's fuel system.

3. Connect OMC storage fogging oil can to its fitting on the primer solenoid. Following instructions on the can, fog the engine.

4. As soon as emissions are seen coming from motor, turn engine off by flipping red switch located by primer solenoid. Make sure switch is flipped back to original position after motor stops.

5. Remove flushing unit, and allow engine to cool.

6. Remove the spark plugs by twisting and removing all spark plug leads. Unscrew spark plugs and remove from cylinder head.

7. Examine spark plugs and replace if electrodes are badly worn, insulators are cracked, or they are badly fouled. Sparks plugs may be cleaned with gasoline if replacement is not needed.

8. To reinstall spark plugs, wipe spark plug seats clean with a clean rag. Install spark plugs finger tight, then tighten to specified torque of 18-21 ft. lbs. (24-27 N-m). (Approximately one quarter turn and no more.) **Do not overtighten.**

9. Before installing the spark plug lead, check and apply if necessary, a light coat of triple-guard grease to the ribbed portion of the spark plug insulator and the opening of the spark plug cover. This will help prevent corrosion between the spring terminal and the spark plug.

<u>Gearcase:</u>

1. Replace gearcase lubricant in lower unit at the end of every season. Use only OMC *Hi-Vis* gearcase lubricant.

2. With motor in normal operating position, remove drain/fill plug at bottom of the motor unit located to the front of the propellor.

3. Remove lubricant level plug from the side of the gearcase located on the same side as the drain/fill plug and above the propellor.

4. Completely drain gearcase of old lubricant.

5. Examine drained lubricant for metal filings, milky appearance, or black color with burnt odor. Slight discoloration may be noted but drained lubricant should be fairly transparent. If old lubricant has any of those characteristics, see your local dealer. If drained lubricant is in good condition, proceed with replacing the lubricant.

6. Place tube of lubricant in drain/fill hole and fill slowly until lubricant appears at lubricant level hole.

7. Install lubricant level plug (top plug) before removing tube from drain/fill hole. Drain/fill plug can then be installed without loss of lubricant.

8. Securely tighten both plugs.

9. Change fuel filter after every 100 hours or seasonally whichever comes first. The fuel filter is located in the fuel hose between motor's fuel connector and fuel pump. Disconnect fuel hose from motor before changing fuel filter unit.

10. New fuel filter may be purchased at any authorized dealer.

11. Release the two hose clamps that secure filter to the fuel hose. A partial twist of the clamp lock will release the clamp. **Note direction of flow arrow on filter. Be sure replacement filter is installed in the same direction.** Pull filter from hose and discard.

12. Install new filter and secure hose clamps.

13. Check for leaks by connecting fuel line to motor and squeezing primer bulb until definite resistance is felt in bulb.

14. Check for and tighten any loose screws and nuts.

15. Check electrical, ignition, oil, and fuel systems for misplaced leads and damaged or deteriorated parts. Be sure starter solenoid terminal boot and all connectors are in place.

16. Inspect propellor for nicks and wear. If damaged, see dealer for repairs.

17. Inspect motor exterior and touch up painted surfaces if needed. Wax the motor's exterior.

18. Store the motor on the boat in a vertical, self-draining position.

19. Check the oil injection system by removing the filler cap from the filling oil tank and topping off the tank with Evinrude OMC 2 Cycle Oil. Replace filler cap.

20. Lubricate with tripleguard grease the steering mechanism and throttle control.

21. Battery should be removed from the boat and stored in a cool, dry place, out of direct sunlight over the winter. Clean battery terminals and check charge in battery periodically throughout the winter storage season. Charge as needed or replace when battery will not retain charge.

22. Thoroughly clean the boat. Clean the pontoon logs, deck, and storage areas.

23. Vacuum carpeting on deck and check for wear and/or deterioration.

24. Store boat in building assigned to BEFS at the Federal Surplus Building.

25. Loosen all tie-downs to reduce stress on the boat.

B. Lowe Industries 14-foot Jon Boat

Prepare engine for winter storage by completing the recommended guidelines taken from the Operation and Maintenance Manual for the 9.9 Evinrude Motor as follows:

Motor:

1. To ensure proper water circulation through motor, attach Flush-Rite Muff flushing unit according to instructions on the box using caution to not use excessive water pressure. This unit is to be attached over the water intake openings while motor is being run for winterization.

2. Check for leaks by connecting fuel line to motor and squeezing primer bulb until definite resistance is felt in bulb.

3. To minimize condensation, fuel tanks should be filled and a gasoline stabilizer added. Follow manufacture's instructions on gas treatment container. Engine is then started and allowed to fast idle for approximately five minutes to distribute the stabilized fuel through engine's fuel system.

4. Remove gas line from engine and store gas container in the designated barrel with lid, making sure the lid is secured in place with a tarp strap.

5. Allow engine to cool.

6. Remove the spark plugs by twisting and removing spark plug leads. Unscrew spark plugs and remove from cylinder head.

7. Examine spark plugs and replace if electrodes are badly worn, insulators are cracked, or plugs are badly fouled. Spark plugs may be cleaned with gasoline if replacement is not needed.

8. Spray fogging oil into each spark plug how. Manually rotate the power head to coat the inside of the cylinder piston walls.

9. To reinstall spark plugs, wipe spark plug seats clean with a clean rag. Install spark plugs finger tight, then tighten to specified torque of 18-21 ft. lbs. (24-27 N-m). (Approximately one quarter turn.) **Do not overtighten**.

Gearcase:

1. Replace gearcase lubricant in lower unit at the end of every season. Use only OMC *Hi-Vis* gearcase lubricant.

2. With motor in normal operating position, remove drain/fill plug at bottom of the motor unit located to the front of the propellor.

3. Remove lubricant level plug from the side of the gearcase located on the same side as the drain/fill plug and above the propellor.

4. Completely drain gearcase of old lubricant.

5. Examine drained lubricant for metal filings, milky appearance, or black color with burnt odor. If old lubricant has any of those characteristics, see your local dealer. If drained lubricant is in good condition, proceed with replacing the lubricant. Slight discoloration may be noted but drained lubricant should be fairly transparent.

6. Place tube of lubricant in drain/fill hole and fill slowly until lubricant appears at lubricant level hole.

7. Install lubricant level plug (top plug) before removing tube from drain/fill hole. Drain/fill plug can then be installed without loss of lubricant.

8. Securely tighten both plugs.

9. Check for and tighten any loose screws and nuts. Inspect rivets for cracking or deterioration. If repairs are needed, contact local welding service.

10. Check electrical, ignition, oil, and fuel systems for misplaced leads and damaged or deteriorated parts. Be sure starter solenoid terminal boot and all connectors are in place.

11. Inspect propellor for nicks and wear. If damaged, see local dealer for repairs.

12. Inspect motor exterior and touch up painted surfaces if needed. Wax the motor's exterior.

13. Store the motor on the boat in a vertical, self-draining position.

14. Thoroughly clean the boat.

15. Lubricate steering mechanism and throttle control.

16. Store boat in building assigned to BEFS at the Federal Surplus Building.

III. PROCEDURES FOR TRAILER MAINTENANCE

A. Tracker Marine Corporation Pontoon Boat Trailer

Prepare trailer for winter storage by following the guidelines, below, on wheel bearing cleaning, packing, and/or replacement. Use manufacturer approved grease to pack and/or replace wheel bearings.

1. Jack trailer up and place blocks under axle on both sides by wheels.

2. Check for play in tire while on hub and spin on tire (tire should not wobble and should spin freely and without wobble)

3. Remove bearing protector ("Bearing Buddy") with rubber mallet. Strike edge of buddy and turn tire until crack appears around edge. Continue striking buddy until it comes off.

4. Pour solvent into container to clean parts of hub, bearings, bearing protector, and spindle. (Using a paint brush works well.)

5. Remove tire from trailer. (Rim may need to be cleaned and painted to prevent rusting.)

6. Remove cotter pin and retaining nut.

7. Dab with solvent to begin cleaning.

8. Straighten cotter pin with pliers.

9. Mark on retaining nut where cotter pin was last located.

10. Remove cotter pin with pliers.

11. Cotter pin will need to be replaced every time.

12. Remove retaining nut (should be able to loosen by hand).

13. Place retaining nut in solvent to clean.

14. Remove the two washers that are located behind retaining nut.

15. Remove entire hub from spindle. Difficulty in removing hub, or presence of rust colored spots in grease or black grease, may indicate problem with bearings.

16. Place entire unit in solvent and clean, making sure all grease is removed.

17. Clean spindle with solvent to remove all old grease.

18. Drive bearing and seal out of hub. One bearing will be loose and should fall out. Using the appropriate size socket, place inside hub and strike with hammer to remove seal and other bearing.

19. Clean hub (inside and out) and bearings with solvent, making sure all grease and dirt is removed.

20. Look for wear on bearings and on inside of races. Wear will be on rollers that are on the bearing and on races inside hub. Bearings may also have play when turning. If any wear shows - replace bearings (replace in pairs and preferably both wheels at the same time.)

21. Spindle should be previously cleaned with solvent and allowed to **dry completely**. Check for any roughness on spindle and if there is any, use an emory cloth to smooth out, paying particular attention where seal rides on spindle towards back of unit.

22. Thoroughly clean “Bearing Buddy” with solvent and allow to dry.

23. **If bearings do not need to be changed**, continue on to clean all parts and proceed repacking of bearings and wheel. Do not replace races. Allow all parts to dry after cleaning.

24. **If bearings need to be replaced**, drive races out of hub (these are the inserts that the bearings ride on inside hub). Using a punch, place it on lip of race and strike with hammer until it comes free. Turn hub over, place inside tire and remove other race.

25. Clean inside of hub again with solvent and let dry.

26. Keep old races for use in installing new races if bearings are being replaced. Old races can be placed alongside new races to prevent marring when pounding new races into place with mallet.

27. At this point, go to Parts Store to obtain 2 new seals which must always be replaced. If bearings need to be replaced, obtain American made bearings as they are a higher quality than most. Races come with the bearings. When buying replacement parts, take old cotter pins, seals and bearings to store to ensure proper match. **Cotter pins and seals must always be replaced.**

REPLACEMENT:

1. Install races by starting into each side of hub and finish tapping into place with punch.
2. Make sure punch does not scratch inside of race.

3. Tap race into place, fitting it securely in place inside hub against the small lips on inside of hub.

REPACKING:

1. Start on side that will hold seal. (This will be the side with the bolt heads to the inside so that the threads will face outward so tire can be put on.)

2. Put grease all over bearing, making sure all areas are coated with grease, making sure grease is packed into the spaces on front and back of bearings as well as the rollers.

3. Apply a small amount of grease coating on race and place bearing into hub.

4. Run a good bead of grease on top of bearing and replace seal.

5. To install new seal into wheel bearing hub, use a dampener (block of wood) and tap seal into place. Check to see if the new seal is flush and straight to ensure correct operation.

6. Put film of grease on axle (or spindle).

7. Fill inside of hub with grease from grease gun.

8. Grease other bearing as described previously and place into hub.

9. Slide unit onto spindle with seal towards back.

10. Push grease back into hub compartment.

11. Rotate hub to work grease in.

12. Install the 2 washers onto spindle.

13. Replace retaining nut. Hand tighten nut and then using a wrench tighten as tight as possible and then back it off to the nearest slot so cotter pin may be installed.
14. Rotate hub so that it turns approximately 1.5 times when spun.

15. Replace cotter pin into slot and bend the ends out and up.

16. Reinstall the bearing protector using a dampener (block of wood) to drive the protector onto the wheel bearing hub.

17. Clean outside of bearing protector so it is free of grease.

18. Replace tire.

19. Place grease gun on grease zerk in the middle of the bearing protector. This protector has an internal piston that moves forward to show that the proper level has been reached. Air may be heard escaping the piston while being filled with grease. Once installed and filled all that needs to be done to check the grease level is to push on the piston.

20. Replace dust cap on bearing protector.

21. Take trailer off jacks and tighten bolts down to securely attach tire.

22. Inspect trailer thoroughly for signs of wearing or cracking, especially along fender wells. If cracks are discovered, take trailer to local welding service for repair.
23. Block the trailer wheels off the cement floor of storage building to avoid tire deterioration.

24. Complete Maintenance Schedule Checklist and place in Equipment Maintenance and Document Book in appropriate section for the pontoon boat.

B. Low Industries 14-foot Jon Boat Trailer

Prepare trailer for winter storage by following the guidelines, below, on wheel bearing cleaning, packing, and/or replacement. Use manufacturer approved grease to pack and/or replace wheel bearings.

1. Jack trailer up and place blocks under axle on both sides by wheels.

2. Check for play in tire while on hub and spin on tire (tire should not wobble and should spin freely and without wobble)

3. Remove bearing protector ("Bearing Buddy") with rubber mallet. Strike edge of protector and turn tire until crack appears around edge. Continue striking protector until it comes off.

4. Pour solvent into container to clean parts of hub, bearings, bearing protector, and spindle. (Using a paint brush works well.)

5. Remove tire from trailer (clean and repaint rim, if rusting).

6. Remove cotter pin and retaining nut.

7. Dab with solvent to begin cleaning.

8. Straighten cotter pin with pliers.

9. Mark on retaining nut where cotter pin was last located.

10. Remove cotter pin with pliers.

11. Cotter pin will need to be replaced every time.

12. Remove retaining nut (should be able to loosen by hand).

13. Place retaining nut in solvent to clean.

14. Remove the two washers that are located behind retaining nut.

15. Remove entire hub from spindle. Difficulty in removing hub, or presence of rust colored spots in grease or black grease, may indicate problem with bearings.

16. Place entire unit in solvent and clean, making sure all grease is removed.

17. Clean spindle with solvent to remove all old grease.

18. Drive bearing and seal out of hub. One bearing should be loose and fall out. Using the appropriate size socket, place inside hub and strike with hammer to remove other bearing and seal.

19. Clean hub (inside and out) and bearings with solvent, making sure all grease and dirt is removed.

20. Look for wear on bearings and on inside of races. Wear will be on rollers that are on the bearing and on races inside hub. Bearings may also have play when turning. If any wear shows - replace bearings (replace in pairs and preferably both wheels at the same time.)

21. Spindle should be previously cleaned with solvent and allowed to **dry completely**. Check for any roughness on spindle and if there is any, use an emery cloth to smooth out, paying particular attention where seal rides on spindle towards back of unit.

22. Thoroughly clean "Bearing Buddy" with solvent and allow to dry.

23. **If bearings do not need to be changed**, continue on to clean all parts and proceed repacking of bearings and wheel. Do not replace races. Allow all parts to dry after cleaning.

24. **If bearings need to be replaced**, drive races out of hub (these are the inserts that the bearings ride on inside hub). Using a punch, place it on lip of race and strike with hammer until it comes free. Turn hub over, place inside tire and remove other race.

25. Clean inside of hub again with solvent and let dry.

26. Keep old races for use in installing new races if bearings are being replaced. Old races can be placed alongside new races to prevent marring when pounding new races into place with mallet.

27. At this point, go to Parts Store to obtain 2 new seals which must always be replaced. If bearings need to be replaced, obtain American made bearings as they are a higher quality than most. Races come with the bearings When buying new parts, take old cotter pins, seals and bearings to store for comparison. **Cotter pins and seals must always be replaced.**

REPLACEMENT:

1. Install races by starting into each side of hub and finish tapping into place with punch.

2. Make sure punch does not scratch inside of race.

3. Tap race into place, fitting it securely in place inside the hub against the small lips on inside of hub.

REPACKING:

1. Start on side that will hold seal. (This will be the side with the bolt heads to the inside so that the threads will face outward so tire can be put on.)

2. Put grease all over bearing, making sure all areas are coated with grease, making sure grease is packed into the spaces on front and back of bearings as well as the rollers.

3. Apply a small amount of grease coating on race and place bearing into hub.

4. Run a good bead of grease on top of bearing and replace seal.

5. To install new seal into wheel bearing hub, use a dampener (block of wood) and tap seal into lace. Check to see if the new seal is flush and straight to ensure correct operation.
6. Put film of grease on axle (or spindle).

7. Fill inside of hub with grease from grease gun.

8. Grease other bearing as described previously and place into hub.

9. Slide unit onto spindle with seal towards back.

10. Push grease back into hub compartment.

11. Rotate hub to work grease in.

12. Install the 2 washers onto spindle.

13. Replace retaining nut. Hand tighten nut and then using a wrench tighten as tight as possible and then back it off to the nearest slot so cotter pin may be installed.
14. Rotate hub so that it turns approximately 1.5 times when spun.

15. Replace cotter pin into slot and bend the ends out and up.

16. Reinstall the bearing protector using a dampener (block of wood) to drive the protector onto the wheel bearing hub.

17. Clean outside of bearing protector so it is free of grease.

18. Replace tire.

19. Place grease gun on grease zerk in the middle of the bearing protector. This protector has an internal piston that moves forward to show that the proper level has been reached. Air may be heard escaping the piston while being filled with grease. Once installed and filled all that needs to be done to check the grease level is to push on the piston.

20. Replace dust cap on bearing protector.

21. Take trailer off jacks and tighten bolts down to securely attach tire.

22. Inspect trailer thoroughly for signs of wearing or cracking, especially along fender wells. If cracking is noted along fender wells, have repair work completed at a local welding service.

23. Block the trailer wheels off the cement floor of storage building to avoid tire deterioration.

24. Complete Maintenance Schedule Checklist and place in Equipment Maintenance and Document Book in appropriate section for the Jon boat.

APPENDIX C

STANDARDIZED FIELD AND LABORATORY FORMS

AND DATA RECORDING SHEETS

LAKE AND WETLAND FIELD DATA SHEET
FORM APP.C-1

LAKE SURVEY FIELD DATA SHEET

LAKE: _____ ID NUMBER: _____

DATE: _____ (MM/DD/YY) 24 HR TIME: _____ CREW: _____

SKY: _____ WIND: _____ MPH AIR TEMP _____ DEGREES C

DEPTH (M)	TEMP DEGREES C	DO (mg/L)	LIGHT (umol/m2/s)
0.0			
0.5			
1.0			
2.0			
3.0			
4.0			
5.0			
6.0			
7.0			
8.0			
9.0			
10.0			
11.0			
12.0			
13.0			
14.0			
15.0			
16.0			

	SI	S2	BI	B2	QAQC
DEPTH	0.5	0.5			
pH					
Chl a					

SECCHI DEPTH _____ cm

SURFACE WINKLER DO _____ mg/L

OTHER OBSERVATIONS: _____

TROPHIC STATE SCORE: _____

KHEL SAMPLE SUBMISSION FORM
INORGANIC ANALYSES
FORM APP.C-2a

CHEMISTRY
FIELD SHEET
PROJECT OR LAKE _____
SITE ID NO LM044201

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF ENVIRONMENT
DATA FORM

COLLECTOR(S): _____
COLLECTION DATE: _____, 2000
DATE RECEIVED: _____
SEND REPORT TO: _____

SAMPLE LOCATION FOR ABOVE LAKE	LAB I.D. NO.	DEPTH	TIME	HEAVY METALS	Hg	NUTRIENT	TP	TKN	CHEM	TDS	TSS	SP COND	TURB	OTHER	REMARKS
STA. 1 SURFACE 1									CUBE					Ortho-P TOC	
STA. 1 SURFACE 2									CUBE					Ortho-P TOC	
STA. 1 BOTTOM 1									CUBE					Ortho-P TOC	
STA. 1 BOTTOM 2									CUBE					Ortho-P TOC	

CHAIN OF CUSTODY

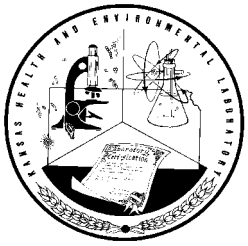
DATE RECEIVED: _____

RECEIVED FROM _____

RECEIVED BY: _____

TIME RECEIVED _____

KHEL SAMPLE SUBMISSION FORM
ORGANIC ANALYSES
FORM APP.C-2b



Kansas Health and Environmental Laboratory
Department of Health and Environment
Forbes Field, Building 740
Topeka, Kansas 66620-8420

Lab Number: _____
Date Received:_____
Sample Submission Form Analysis Code:PX,HX_____

Report to: Ed Carney Address: Bureau of Environmental Field Services

Collection Site: _____
Site ID Number: LM_____ Collection Depth:___
0.5 _____
Feet
Sample Description: Water Date: _____
-2000
Sample Collector: _____
Name
Agency (Abbr) KDHE Time: ___ ___ ___
___
Program Code: LM 24 Hour

Organic Chemistry Laboratory

Check Desired Analysis: [ ] Other _____ VOC Sample [ ]

[ ]	Volatiles	Method:	[ ]	624	[X]	Pesticides	Method:	[X] 608
[ ]	Acids	Method:	[ ]	625	[ ]	Base/Neutrals	Method:	[ ] 625
[ ]	PCB's	Method:	[ ]	608	[X]	Herbicides	Method:	[X] 615

Inorganic Chemistry Laboratory

Bottle Nos.: Che ____ D ____ NUT ____ H ____ C ____ O&G ____ Phenol ____

Check Desired Analysis: [ ] Other _____

[ ] Metals [ ] Mercury [ ] Minerals [ ] TCLP

Sample Comments: _____

Chain of Custody:

Date_____ Relinquished By: _____

Received By _____

Date_____ Relinquished By: _____

Received By _____

Additional Reports Routed To:

Name _____ Address _____

KHEL SAMPLE SUBMISSION FORM
BACTERIOLOGICAL ANALYSES
FORM APP.C-2c

ENVIRONMENTAL MICROBIOLOGY LAB FORM

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT
DIVISION OF ENVIRONMENT

PROJECT OR LOCATION:

COLLECTOR(S): Carney, Chamberlain
COLLECTION DATE:

LAKE NETWORK LOC. AND WETLANDS LOC.	STA NO.	BACT. BOTTLE NO.	LAB NO. *Special Study SS*	FIELD PARAMETERS		ELISA ATRAZINE	REMARKS *(Will note if suspected high count)*
				TIME	TEMP C		
Jamestown WMA	1-1						
Jamestown WMA	1-2						
Washington WA	1-1						
Washington WA	1-2						
Field Blank							

CHAIN OF CUSTODY

DATE RECEIVED:

RECEIVED FROM:

RECEIVED BY:

MACROPHYTE SURVEY FIELD SHEET
FORM APP.C-3 Front

Macrophyte Survey Sheet

Lake:_____ Date:_____ Time:_____

Site	Species Present
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

MACROPHYTE SURVEY FIELD SHEET
FORM APP.C-3 Back

Macrophyte Survey Sheet, page 2

Total Sample Points = _____ (1)

Total Sample Points Positive for Macrophytes = _____ (2)

Total Areal Cover = (2)/(1) = _____

Total Species Observed and Relative Abundance for Each:

_____	=	+ points/(1)	= _____
_____	=	"	= _____
_____	=	"	= _____
_____	=	"	= _____
_____	=	"	= _____
_____	=	"	= _____
_____	=	"	= _____
_____	=	"	= _____
_____	=	"	= _____
_____	=	"	= _____

A locator map will be attached to this survey sheet.

CHLOROPHYLL-A ANALYSIS/DATA RECORDING SHEET
FORM APP.C-4

Chlorophyll-a Laboratory Data Sheet

Page:_____

Analyst:_____ Date of Analysis:_____

Location	Station Number	Collection Date	Volume Filtered mL	Extract Volume mL	Absorbance Value				Phaeophytin ppb	Chlorophyll-a ppb	TSI
					750B	750A	663B	665A			

ALGAE TAXONOMIC DATA SHEET
FORM APP.C-5

Lake Name:	Saint Jacob's Well	Date:	August 29, 2000

Sample is concentrated by 5X prior to counting, unless otherwise noted.
Sample is preserved with Lugol's Iodine, unless otherwise noted.
Counts are based on 50 microscope fields, unless otherwise noted.

Class	Genera	Counts Genera	Total Class Counts	Sizing Factor	Number per mL	mm3/mL Individual	ppm Class
Chlorophytes	misc.	22	22	0.2	1386	0.000541	0.541
						0	
						0	
						0	
						0	
						0	
Cyanophytes	Lyngbya	120	120	0.2	7560	0.002953	2.953
						0	
						0	
						0	
						0	
						0	
Diatoms/Chrysophytes	pennate	2	2	0.6	126	0.000148	0.148
						0	
						0	
						0	
						0	
						0	
Dinoflagellates	Ceratium	12	46	15	2898	0.022148	84.901
	sp.	34		15		0.062753	
						0	
Cryptophytes			0		0	0	0.000
						0	
						0	
Euglenoids			0		0	0	0.000
						0	
						0	
Totals					11970	No./mL	88.543 ppm volumetric

Algae Class	Percent Total Count		
Chlorophytes	11.6		0.6
Cyanophytes	63.2		3.3
Diatoms/Chrysophytes	1.1		0.2
Dinoflagellates	24.2		95.9
Cryptophytes	0.0		0.0
Euglenoids	0.0		0.0
Totals	100.0		100.0

APPENDIX D

REFERENCES CITED

REFERENCES CITED

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